RUSSIAN RIVER

Biological Assessment and Essential Fish Habitat Assessment

Prepared for
Sonoma County Water Agency

August 2023

ESA

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Glossary and Acronyms

Glossary

Action Area **-** all areas affected directly or indirectly by the action and not merely the immediate area involved in the action.

Cumulative Effects **-** those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur in the action area of the Federal action subject to consultation.

Discountable Effects **-** effects that are extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.

Effects of the Action **-** the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action. These effects are considered along with the environmental baseline and the predicted cumulative effects to determine the overall effects to the species for the purposes of preparing a biological opinion on the Proposed Action.

Environmental Baseline **-** includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal Programs in the action area that have already undergone formal or early Section 7 consultation, and the impact of State or private actions that are contemporaneous with the consultation in process.

Indirect Effects **-** effects caused by the action(s) and are later in time, but are still reasonably certain to occur.

Interrelated Actions **-** actions that are part of a larger action and depend on the larger action for their justification i.e., this action would not occur, but for a larger action.

Interdependent Actions **-** actions that have no significant independent utility apart from the action that is under consideration, i.e., other actions would not occur but for this action.

Jeopardy **-** to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, number, or distribution of that species.

***May Affect, Not Likely to Adversely Affect* -** the appropriate conclusion when effects on a listed species are expected to be discountable, insignificant, or completely beneficial.

***May Affect, Likely to Adversely Affect* -** the appropriate finding if any adverse effect may occur to listed species or critical habitat as a direct or indirect result of the Proposed Action or its interrelated or interdependent actions, and the effect is not discountable, insignificant, or beneficial.

***Primary Constituent Elements* -** specific elements of physical or biological features that provide for a species' life-history processes and are essential to the conservation of the species.

***Project Area* -** the Project footprint and all areas that may be directly or indirectly affected by the Project. It is smaller than the action area because it does not include the spatial extent of the interrelated and interdependent actions and potential indirect effects associated with the larger Action.

***Take* -** to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct; may include significant habitat modification or degradation if it kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering.

Acronyms and Other Abbreviations

Acronym or Abbreviation	Definition
°C	degrees Celsius
°F	degrees Fahrenheit
°N	degrees North latitude
°S	degrees South latitude
µm	Micrometers
AFY	Acre-feet per year
AMP	Adaptive Management Program
AR	Atmospheric river
BA	Biological Assessment
BML	Bodega Marine Laboratory
BMP	Best Management Practice
BO	Biological Opinion
CAP	Continuing Authorities Program
CCC	Central California Coast
CDFW	California Department of Fish and Wildlife
CDP	Coastal Development Permit
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
Coastal Commission	California Coastal Commission
CoSMoS	Coastal Storm Modeling System
CPUE	Catch per unit effort
CSG	California Sea Grant
CSP	California State Parks
CSWP	Central Sonoma Watershed Project
CVD	Coyote Valley Dam
CVFF	Coyote Valley Fish Facility
CW3E	Center for Western Weather and Water Extremes
DCFH	Don Clausen Fish Hatchery
Deviation	Planned Major Deviation

Acronym or Abbreviation	Definition
DO	dissolved oxygen
DPS	Distinct Population Segment
DSMT	Downstream Migrant Trap
EFH	Essential Fish Habitat
EIR	Environmental Impact Report
ERT	Electrical Resistivity Tomography
ESA	Environmental Science Associates
Estuary	Russian River Estuary
ESU	Evolutionarily Significant Unit
FCS	Flood Control Schedule
FERC	Federal Energy Regulatory Commission
FESA	federal Endangered Species Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FIRO	Forecast Informed Reservoir Operations
Fish Flow Project	Fish Habitat Flows and Water Rights Project
Flow Schedules	Minimum instream flow schedules
FMP	Fisheries Management Plan
FR	*Federal Register*
GPR	ground penetrating radar
GRSB	Goat Rock State Beach
HAPC	Habitat Area of Particular Concern
HFA	Habitat Focus Area
HGMP	Hatchery Genetic Management Plan
Inflow Condition	cumulative inflow into Lake Mendocino
ITS	Incidental Take Statement
km	Kilometers
LBNL	Lawrence Berkeley National Laboratory
LCM	Life-cycle Modeling
LCS	Life-cycle Stream
LiDAR	Light Detection and Ranging
LMHPP	Lake Mendocino Hydroelectric Power Plant
LWM	Large Woody Material
MAMP	Monitoring and Adaptive Management Plan

Acronym or Abbreviation	Definition
MW	megawatt
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MCRRFCD	Mendocino County Russian River Flood Control and Water Conservation Improvement District
mg/L	milligrams per liter
mm	Millimeters
MOU	Memorandum of Understanding
MSL	Mean sea level
NCPA	Northern California Power Authority
NCRWQCB	North Coast Regional Water Quality Control Board
NEPA	National Environmental Policy Act
NGVD29	National Geodetic Vertical Datum of 1929
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OCOF	Our Coast, Our Future
O&M	Operations and Maintenance
OMRR&R	Operation, Maintenance, Repair, Rehabilitation, and Replacement
OWC	Organic Waste Compound
PCE	Primary Constituent Element
PG&E	Pacific Gas & Electric
PIT	Passive Integrated Transponder
PPFC	Public Policy Facilitating Committee
ppt	parts per thousand
PVID	Potter Valley Irrigation District
PVP	Potter Valley Project
PWRPA	Power and Water Resource Pooling Authority
QCM	Quantified Conceptual Model
RCP	Reinforced concrete pipe
rkm	river kilometer
RPA	Reasonable and Prudent Alternative
RPM	Reasonable Prudent Measure
RRIC	Russian River Improvement Company

Acronym or Abbreviation	Definition
RVCWD	Redwood Valley County Water District
SMP	Stream Maintenance Program
Sonoma Water	Sonoma County Water Agency
SR	Seismic Refraction
Storage Condition	Lake Mendocino storage levels
SWRCB	State Water Resources Control Board
TAC	Technical advisory committee
TMDL	Total Maximum Daily Load
TUCO	Temporary Urgency Change Order
TUCP	Temporary Urgency Change Petition
UC Davis	University of California, Davis
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WCM	Water Control Manual
WSD	Warm Springs Dam
WSDHF	Warm Springs Dam Hydroelectric Facility
WUA	Weighted Usable Area
WY	Water Year
YOY	Young of the Year

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SECTION 1
Introduction

1.1 Background

On September 24, 2008, the National Marine Fisheries Service (NMFS) issued a 15-year Biological Opinion (*2008 Biological Opinion*) for water supply, flood control operations, and channel maintenance (Action) conducted by the U.S. Army Corps of Engineers (USACE), Sonoma County Water Agency (Sonoma Water), and Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD) in the Russian River watershed (**Figure 1-1**).[1] The *2008 Biological Opinion* authorizes incidental take under the federal Endangered Species Act (FESA) of the threatened California Coastal Chinook Salmon evolutionarily significant unit (ESU) (*Oncorhynchus tshawytscha*) and Central California Coast (CCC) steelhead distinct population segment (DPS) (*Oncorhynchus mykiss*), and endangered CCC Coho Salmon ESU (*Oncorhynchus kisutch*), with implementation of a Reasonable and Prudent Alternative (RPA) for management of reservoir releases, river minimum instream flows, habitat conditions, and facilities in portions of the mainstem Russian River, Santa Rosa Creek watershed, Dry Creek, and Russian River Estuary (Estuary). Because Coho Salmon are also listed as endangered under the California Endangered Species Act (CESA), Sonoma Water is party to a Consistency Determination (Fish and Game Code section 2080.1) issued by the California Department of Fish and Wildlife (CDFW) in November 2009, which also provides coverage for a 15-year duration.

USACE and Sonoma Water management activities span the Russian River watershed from Coyote Valley Dam (CVD) and Warm Springs Dam (WSD) to the Russian River Estuary, including several tributaries. USACE and Sonoma Water operate and maintain facilities and conduct activities related to flood control, water diversion and storage, instream flow releases, estuary management, hydroelectric power generation, channel maintenance, and fish production.

1.2 Purpose and Scope of the Biological Assessment

This Biological Assessment (BA) has been prepared to support reinitiation of consultation with NMFS under Section 7 of FESA. The purpose of this BA is to review the Proposed Action in sufficient detail to assess potential effects on federally-listed threatened or endangered species,

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[1] National Marine Fisheries Service (NMFS). 2008. Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. Prepared for the U.S. Army Corps of Engineers, San Francisco District. September 24, 2008.

SOURCE: NHD (2021)

RRBA

Figure 1-1
Russian River Watershed

ESA

candidate and/or proposed for listing species under the jurisdiction of NMFS and U.S. Fish and Wildlife Service (USFWS). The BA is prepared in accordance with requirements set forth under Section 7 of FESA (16 U.S. Code [USC] 1536[c]). Under provisions of Section 7(a)(2) of FESA, a federal agency that permits, licenses, funds, or otherwise authorizes activities must consult with USFWS and NMFS, as appropriate, to ensure that its action will not jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat.

This BA also evaluates effects on essential fish habitat (EFH) as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (16 USC 1801 et seq.). This BA also evaluates potential impacts to state-listed threatened or endangered species under CESA, under the jurisdiction of CDFW, and provides information to support CESA coverage for state-listed species.

USACE and Sonoma Water have prepared this BA to describe the actions subject to consultation, including facility operation, maintenance, and existing conservation actions undertaken by the action agencies. The focus of the BA is the assessment of potential effects on listed fish (i.e., salmon and steelhead) species and their critical habitats. The assessment considers potential effects from project operations and maintenance for existing facilities. Specifically, the Proposed Action evaluated in the BA includes the following:

- Reservoir Operations:
    - Discretionary Flood Control Operations at CVD and WSD;
    - Water Supply Operations at CVD and WSD;
- Estuary Management (mouth of the Russian River);
- Channel Maintenance on portions of the mainstem Russian River[2] and Dry Creek, specifically maintenance of facilities associated with CVD and WSD operations;
- Central Sonoma Watershed Project Flood Control Operations;
- Coyote Valley Fish Facility (CVFF) and Don Clausen Fish Hatchery (DCFH) Facilities Maintenance;
- Dry Creek Habitat Enhancements; and
- Physical and Biological Monitoring (Russian River watershed).

Flood control operations at CVD and WSD include both non-discretionary and discretionary federal actions. Non-discretionary actions are those activities that are required to maintain Civil Works structures so that they continue to serve their Congressionally authorized purposes and are inherent in the authority to construct them. Non-discretionary federal actions at CVD and WSD include dam security and enforcement, dam safety inspections, implementation of the 1986 Lake Mendocino Water Control Manual (WCM) (not including discretionary deviations to the WCM

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[2] Channel maintenance actions on the Russian River will be undertaken solely by the Mendocino County Russian River Flood Control & Water Conservation and Improvement District. Sonoma Water channel maintenance will be limited to Dry Creek.

with application of FIRO procedures), annual pre-flood inspections, and periodic five-year inspections. Discretionary actions at CVD and WSD include deviations to the WCM with application of forecast-informed reservoir operations (FIRO) procedures. USACE has also proposed discretionary (voluntary) conservation measures to avoid and minimize potential adverse effects at CVD and WSD, which include minimum flows and ramping rates associated with annual pre-flood inspections and periodic five-year inspections (non-discretionary activities). Additional details on non-discretionary and discretionary actions at CVD and WSD, including rationale for determinations, is provided in Section 3, *Description of the Proposed Action* and **Appendix A**, Non-Discretionary and Discretionary Federal Actions at Coyote Valley Dam and Warm Springs Dam.

Hydroelectric project operations at CVD and WSD and hatchery management at CVFF (at CVD), and DCFH (at WSD), and Stream Maintenance Program (SMP) activities were included as part of the Proposed Action in the *2008 Biological Opinion*; however, these activities currently have their own FESA coverage through separate processes and consultations. As a result, they are not included as part of the Proposed Action in this consultation. Additional details on these activities are provided in Section 4, *Environmental Baseline*.

In addition to potential effects to listed fish species from project operations and maintenance, the BA must consider the effects of interrelated and interdependent actions. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no significant independent utility apart from the action that is under consideration. Interrelated and interdependent actions are activities that would not occur “but for” the Proposed Action. Interrelated and interdependent actions considered in this BA include operation and maintenance of Sonoma Water’s water diversion, treatment, and transmission system.

The BA also considers potential cumulative effects from future nonfederal actions. Cumulative effects include the effects of state, tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in the BA. Future federal actions that are unrelated to the Proposed Action are not considered in this section because they require separate consultation pursuant to Section 7 of the FESA. Many actions that have the potential to affect listed fish species or their habitats require a federal permit or funding. The scope of cumulative actions focuses on state, tribal, local, or private actions that are underway or are reasonably certain to occur within the time frame addressed by the BA.

FESA prohibits the unauthorized “take” of listed species. Take as defined under FESA includes harm to an individual. Therefore, in evaluating potential effects of project operations and maintenance activities, this document will find a conclusion of *likely to adversely affect* if any individual fish could be harmed by the Proposed Action, even if the risk of an adverse effect to the overall population is low. Such a conclusion will mean that one or more individual listed fish might be harmed by the Proposed Action. Incidental “take” may be authorized by NMFS through issuance of an incidental take statement. Incidental take is take of a listed species that occurs as a result of conducting otherwise lawful activities that do not specifically target listed species. Additionally, a conclusion of *destruction* or *adverse modification* of critical habitat will be found if effects of the Proposed Action result in direct or indirect alternation that appreciably diminishes the value of critical habitat for both the survival and recovery of a species.

The Proposed Action would have both beneficial and adverse effects on listed salmonids and their designated critical habitat. However, the Proposed Action includes many changes to operations and maintenance that were made with the express purpose of reducing or eliminating project effects that were found in the evaluation of baseline conditions. This represents a substantial improvement over current operations with respect to adverse effects on listed salmonids.

When USACE submits a final BA containing the information required to conduct a thorough analysis of the effects of implementing the Proposed Action on listed species and their habitat to NMFS, a formal consultation under the FESA will be reinitiated. NMFS will then prepare a biological opinion for the Proposed Action. The biological opinion will contain an assessment of the effects of the Proposed Action on the listed fish species. NMFS will evaluate the potential effects of the Proposed Action relative to baseline conditions to determine whether the activities of the Proposed Action are likely to jeopardize the continued existence of the populations under consultation or adversely modify their critical habitat. Its conclusion and supporting analysis will be presented in the biological opinion. As a part of the biological opinion, NMFS will issue an incidental "take" statement to the USACE to cover "take" associated with the performance of USACE, Sonoma Water, and the Mendocino County Russian River Flood Control & Water Conservation and Improvement District (MCRRDC&WCID) activities included in the project description. USACE is responsible for seeing that USACE, Sonoma Water, and MCRRDC&WCID comply with the incidental take statement, including adhering to take limits, reasonable and prudent measures (RPMs), and its other terms and conditions. USACE is seeking a biological opinion that will provide coverage for activities described in the Proposed Action for a ten-year period.

This BA presents the project description for activities undertaken by the USACE and Sonoma Water. It includes the ongoing operations and maintenance activities necessary for providing essential services to the communities in the Russian River watershed and Sonoma Water's service area. It also includes a description of modifications to current operations and maintenance procedures that are being considered for implementation. This BA provides a description of the environmental baseline associated with current project operations and with other activities that have affected habitat conditions in the Russian River. The document is structured as follows:

- Section 1, *Introduction*, presents the structure of the consultation, the regulatory history of the listings pertaining to salmon and steelhead in the Russian River, and a summary description of the action area.
- Section 2, *Consultation to Date*, provides a description of the agency consultation to date.
- Section 3, *Description of the Proposed Action*, presents a description of the Proposed Action under consideration, including operations and maintenance activities associated with project facilities. Descriptions of changes in operation and maintenance practices implemented since the *2008 Biological Opinion* are also presented in Section 4. The changes in operations and maintenance and the additional facilities are proposed, in part, to avoid injury to, or to improve habitat conditions for, listed salmonids. Section 3 also includes a description of

proposed conservation measures, which have been included as part of the Proposed Action to avoid and minimize potential adverse effects to listed fish species, and to address uncertainties associated with the current status of species and habitat conditions in the watershed.

- Section 4, *Environmental Baseline*, includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal Programs in the action area that have already undergone formal or early Section 7 consultation, and the impact of State or private actions that are contemporaneous with the consultation in process. The section provides a general description of the Russian River watershed as it pertains to the listed species analyzed and a discussion of hydrology, water quality, and geomorphic conditions throughout the watershed. This section also includes a description of the status of actions completed or in progress since the publication of the *2008 Biological Opinion* (*2008 Biological Opinion* Proposed Action Reasonable and Prudent Alternative actions).
- Section 5, *Status of Species and Critical Habitat*, provides a description of the status of the listed species, their geographic distribution, and their habitat conditions.
- Section 6, *Effects of the Proposed Action*, contains the effects analysis for the Proposed Action described in Section 3 on Coho Salmon, Chinook Salmon, and steelhead and their respective habitats. The effects associated with the modified operations and proposed new facilities are compared to the effects identified under the baseline in Sections 4 and 5. In addition to the evaluation of potential effects from modifications to project operations, the effects of ongoing operations and maintenance practices are also identified for each species and life-stage. Both direct and indirect effects of the Proposed Action are considered. Factors considered in the effects analysis include the relationship of the affected area to the species distribution, the affected life history stage, the type of effect, the duration or frequency of the effect, and the response of the listed species to the effect. Section 6 also presents the effects of interrelated, interdependent, and cumulative actions.
- Section 7, *Conclusions and Determinations*, provides the FESA- and CESA-based conclusion statements for the effects of the Proposed Action on the federally- and State-listed species.
- Section 8, *Essential Fish Habitat*, provides a description of designated EFH within the action area, along with a description of potential effects from the Proposed Action.
- Section 9, *Marine Protected Areas*, provides a description of Marine Protected Areas (MPAs) within the action area, along with a description of potential effects from the Proposed Action.
- Section 10, *Literature Cited*, presents the references cited in the document and the information obtained from personal communications with other individuals.

1.3 Action Area

The Action Area is defined as all areas affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). Most of the direct and indirect effects of the project occur in:

- the East Branch Russian River below CVD and the mainstem Russian River from the confluence of the East Branch Russian River to the mouth of the Russian River at Jenner (including the Estuary);

- the Santa Rosa Creek sub-watershed including facilities managed as part of the Central Sonoma Watershed Project; and
- Dry Creek downstream of WSD.

Interrelated and interdependent activities, such as water transmission, which would not occur but for the Proposed Action, can also occur in or near streams in Sonoma County outside of the areas delineated above.

1.4 Species, Critical Habitat, and Essential Fish Habitat Considered in this Biological Assessment

This section identifies the State- (CESA) and federally-listed (FESA) fish species that may occur in the Action Area. The presence of critical habitat and EFH in the action area is also described, with further detail provided in Section 5, *Status of Species and Critical Habitat*. Designated critical habitat within the action area is shown in **Figure 1-2**.

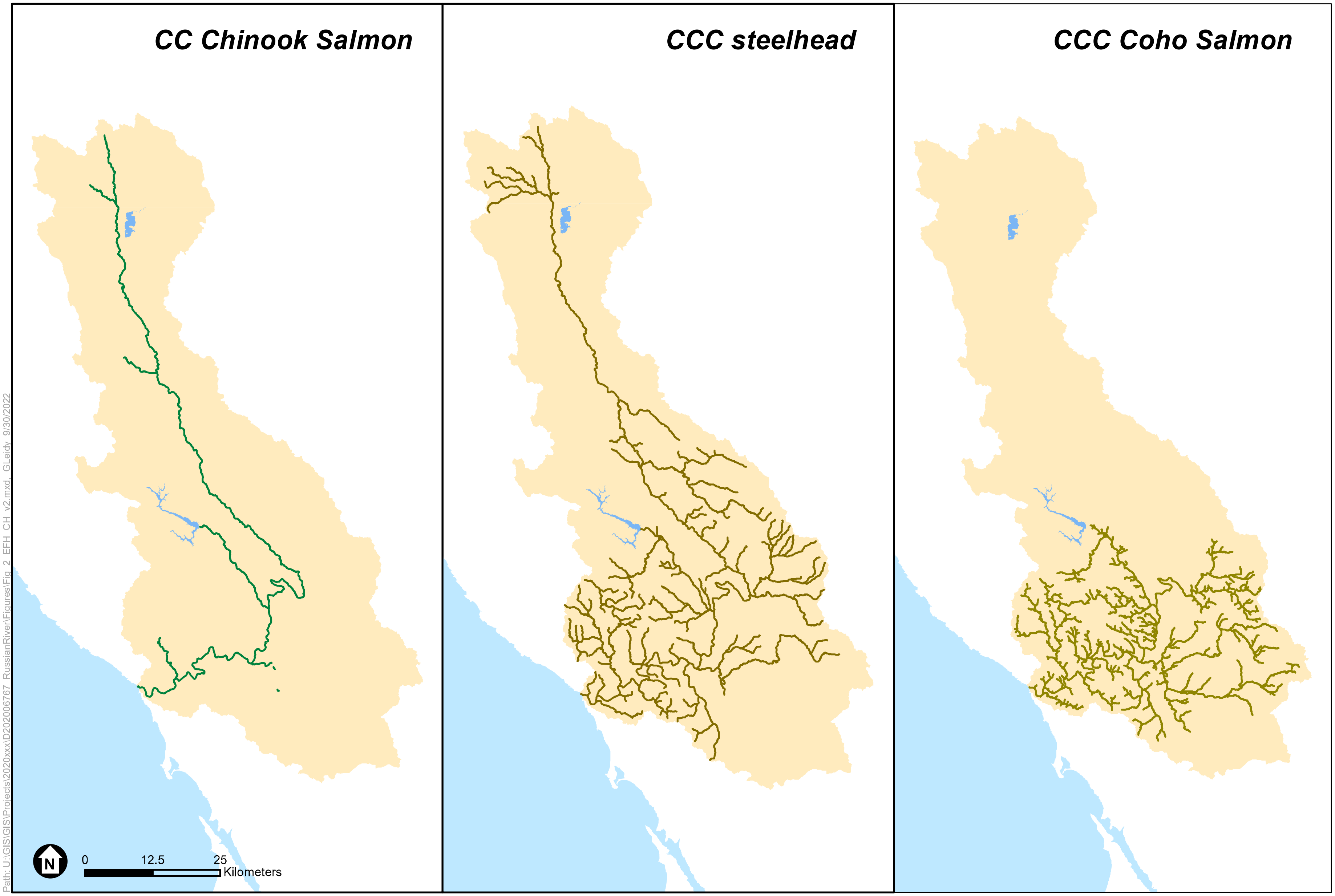
The following species are listed as either threatened or endangered under the FESA and CESA. These species and, where relevant, their critical habitat may be affected by the Proposed Action and are therefore covered in this BA:

- Coho Salmon (*Oncorhynchus kisutch),* Central California Coast (CCC) Evolutionarily Significant Unit (ESU); **FESA Endangered**; **CESA Endangered**.
- Steelhead (*O. mykiss*), CCC Distinct Population Segment (DPS); **FESA Threatened**.
- Chinook Salmon (*O. tshawytscha),* California Coastal ESU; **FESA Threatened**.
- Longfin Smelt (*Spirinchus thaleichthys*), Bay-Delta DPS; **FESA Candidate and Proposed Endangered**; **CESA Threatened**.

1.4.1 Central California Coast Coho Salmon

The CCC Coho Salmon ESU is defined as all naturally spawned Coho Salmon originating from rivers south of Punta Gorda, California, to and including Aptos Creek, as well as such Coho Salmon originating from tributaries to San Francisco Bay. In accordance with NMFS' 2005 Hatchery Listing Policy, the ESU also includes Coho Salmon from the three following artificial propagation programs: the Don Clausen Fish Hatchery (DCFH) Captive Broodstock Program, the Scott Creek/Kingfisher Flat Conservation Program, and the Scott Creek Captive Broodstock Program (70 *Federal Register* (FR) 37159; 77 FR 19552; 85 FR 81822).

Critical habitat for the CCC Coho Salmon ESU encompasses all accessible river reaches within the ESU (i.e., from Punta Gorda south to the San Lorenzo River), including two streams entering San Francisco Bay: Arroyo Corte Madera del Presidio and Corte Madera Creek. Critical habitat consists of all waterways, substrate, and adjacent riparian zones below long-standing, naturally-impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Areas specifically excluded from critical habitat included historically-occupied habitat upstream of specific dams identified in the FR notice (designated May 5, 1999 [64 FR 24049]) (including WSD and CVD), and Indian tribal lands.



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SOURCE: NMFS (2016)

RRBA

Figure 1-2
Salmon and Steelhead Critical Habitat
Russian River Watershed

1.4.2 Central California Coast Steelhead

The CCC steelhead DPS includes naturally spawned anadromous steelhead originating below natural and manmade impassable barriers from the Russian River to and including Aptos Creek, and all drainages of San Francisco and San Pablo Bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers. This also includes steelhead from the DCFH and Kingfisher Flat Hatchery Program. The Russian River is the largest drainage in the CCC steelhead DPS.

Critical habitat for CCC steelhead DPS encompasses the current freshwater and estuarine range inhabited by the DPS (i.e., from the Russian River (inclusive) south to Aptos Creek (inclusive), including the San Francisco Bay tributaries). Critical habitat consists of all waterways, substrate, and adjacent riparian zones below long-standing, naturally-impassable barriers. As with Coho Salmon, habitat excluded from critical habitat included river reaches upstream of several dams that block access to former anadromous habitats (including WSD and CVD), and Indian tribal lands.

1.4.3 California Coastal Chinook

The California Coastal Chinook Salmon ESU consists of naturally-spawned Chinook Salmon originating from rivers and streams south of the Klamath River to and including the Russian River. The Russian River basin presently contains the southernmost persistent population of Chinook Salmon on the California coast.

Critical habitat for the California Coastal Chinook ESU encompasses accessible reaches of all rivers (including estuarine areas and tributaries) within the current range inhabited by the ESU (i.e., from Redwood Creek (inclusive) in Humboldt County south through the Russian River (inclusive). The critical habitat defined for Chinook Salmon recognized the same exclusions as Coho Salmon and steelhead.

1.4.4 Longfin Smelt

Longfin Smelt was listed as threatened under CESA in 2009. The USFWS concluded that Longfin Smelt did not warrant listing throughout their range as endangered or threatened under FESA, but that the San Francisco Bay-Delta (Bay-Delta) DPS of Longfin Smelt did warrant listing. Subsequently, in October of 2022, USFWS proposed listing the Longfin Smelt Bay-Delta DPS as endangered under FESA (87 FR 60957; published October 7, 2022).

Because Longfin Smelt has not been formally listed under FESA (currently proposed), critical habitat has not been designated. However, USFWS has identified the range of the species, which includes ocean habitat immediately offshore and to the south of the Russian River Estuary; the proposed listing has not specified whether the Russian River Estuary is considered in this range (87 FR 60957).

1.4.5 Other Species Considered

1.4.5.1 California freshwater shrimp

The California freshwater shrimp (*Syncaris pacifica*) was listed as endangered under CESA in 1980 and endangered under FESA in 1988. A 2021 USFWS status review affirmed the FESA endangered listing.[3] Currently, the species is only present in 25 creeks across four drainages (Point Reyes, Salmon Creek, San Francisco Bay, and the Russian River).[4] California freshwater shrimp are typically found in low elevation, low gradient, streams at the edges of pools and under stream banks, exposed root material, or submerged leafy branches.

Observations of freshwater shrimp within the Russian River watershed are sparse. The historical record indicates that shrimp have been documented in a handful of tributaries to the lower Russian River including Blucher Creek, Jonive Creek, Redwood Creek, Green Valley Creek, and East and Big Austin Creeks, although their current status in these creeks is unknown.[5,6,7,8] More recent records are limited although Sonoma Water identified California freshwater shrimp along Hudspeth Creek near its confluence with Jonive Creek and Prunuske Chatham, Inc. identified California freshwater shrimp along an unnamed tributary to Redwood Creek where the species was not previously known. These new localities are tributaries to creeks where the species was previously known to occur (Jonive and Redwood Creeks, respectively) and are nearby previous observations of the species.[9,10]

Based on the distribution of California freshwaters shrimp in the Russian River it is unlikely that the Proposed Action will result in adverse effects on the species. The current distribution of shrimp appears to be limited to small tributaries within the lower Russian River, outside of areas potentially affected by the project. Operations at WSD and CVD will have no impact on hydrology within these tributaries, nor is any channel maintenance or restoration work proposed within these areas. Thus, no indirect effects through habitat modifications are expected to result. While Sonoma Water conducts biological monitoring in the lower watershed, including within Green Valley Creek, it is not anticipated that these actions would result in adverse effects on shrimp. Thus, given the limited occurrence of California freshwater shrimp within the Russian

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[3] U.S. Fish and Wildlife Service. 2021. California Freshwater Shrimp 5-Year Review. Prepared by the U.S. Fish and Wildlife Service, Portland, California.

[4] U.S. Fish and Wildlife Service. 1998. Recovery Plan for the California Freshwater Shrimp. Prepared by the U.S. Fish and Wildlife Service, Sacramento, California.

[5] Hedgpeth, J.W. 1968. The Atyid shrimp of the genus Syncaris in California. Hydrobiol. 53(4):51 1-524

[6] Hedgpeth, J.W. 1975. California fresh and brackish-water shrimps, with special reference to the present status of *Syncaris pacifica* (Holmes). A report prepared for the Office of Endangered Species, U.S. Fish and Wildlife Service. 27 pp. + figures.

[7] Sonoma County Planning Department. 1989. Sonoma County general plan: Land use plan map. Santa Rosa, California

[8] Fleisher, J. 1993. Old Cazadero Road survey for *Syncaris pacifica*. Unpubl. Report. Sonoma County Department of Public Works, Santa Rosa, California.

[9] Sonoma County Water Agency. 2016. TE-808241-4 annual report for 2015 and 2016 project plan. Prepared by Sonoma County Water Agency, Santa Rosa, California. Prepared for U. S. Fish and Wildlife Service, Sacramento, California.

[10] Prunuske Chatham, Inc. 2017. Report of survey for California freshwater shrimp (*Syncaris pacifica*), Service Reference Number 2017-TA-1839. Prepared by Prunuske Chatham, Inc., Sebastopol, California. Prepared for U. S. Fish and Wildlife Service, Sacramento, California.

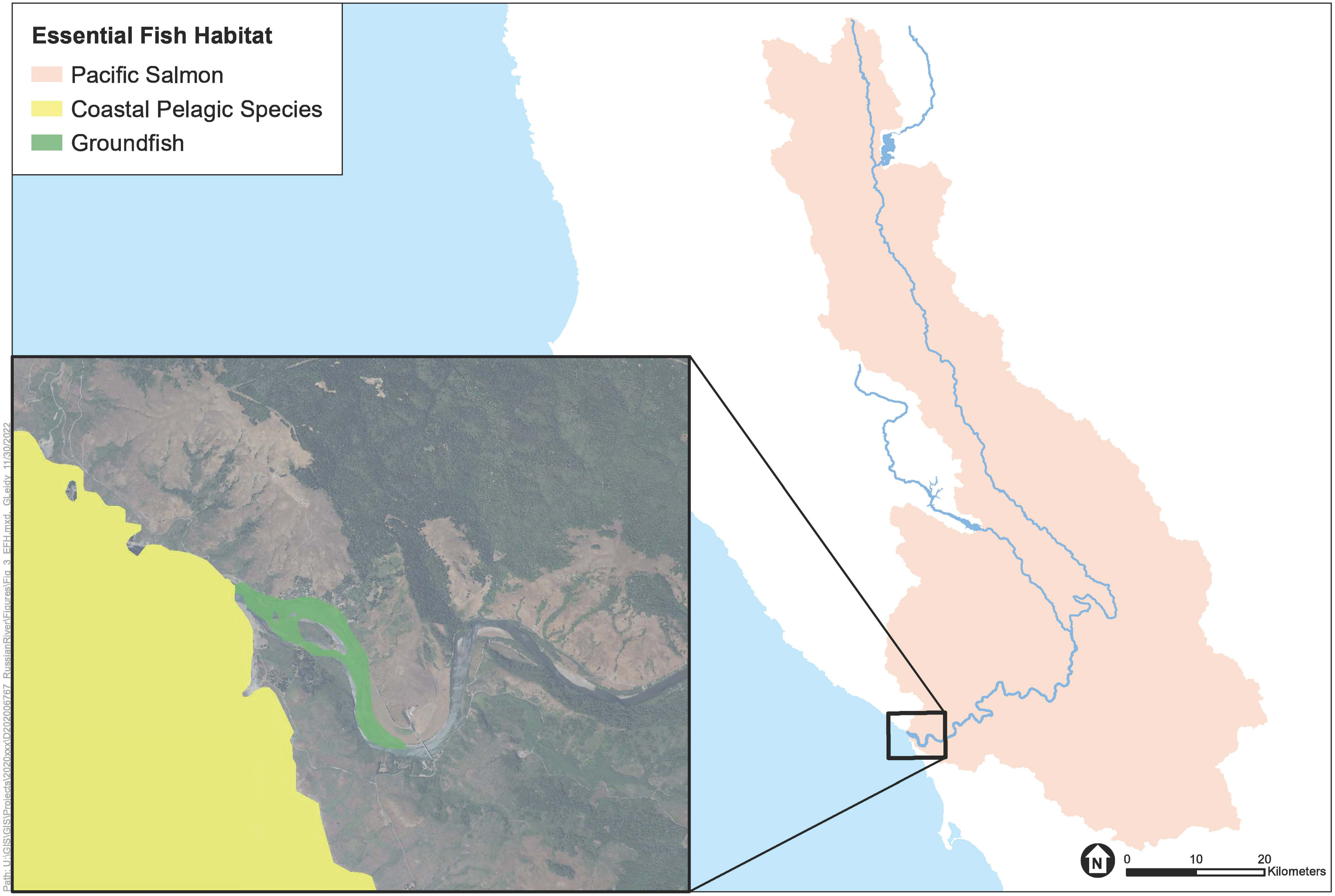
River watershed and the minimal potential for effect, the Proposed Action will result in *No Effect* on California freshwater shrimp.

1.4.6 Essential Fish Habitat

The Action Area addressed within this document falls within EFH, as defined in the MSA, for a large community of commercially important fish and sharks managed under three federal fisheries management plans (FMPs):

- The **Pacific Groundfish FMP**: The Pacific Groundfish FMP is designed to protect habitat for more than 90 species of fish, including rockfish, flatfish, groundfish, some sharks and skates, and other species that associate with the benthic environment; includes the lower portions the Estuary up to approximately the Highway 1 bridge.
- The **Coastal Pelagic FMP**: The Coastal Pelagic FMP is designed to protect habitat for a variety of fish species that are associated with open coastal waters. Fish managed under this plan include planktivores and their predators; includes the lower-most extent of the Estuary up to approximately the barrier beach.
- The **Pacific Coast Salmon FMP**: The Pacific Salmon FMP is designed to protect habitat for commercially important salmonid species including Chinook and Coho salmon, includes portions of Russian River watershed, including the Estuary, accessible to Coho Salmon and Chinook Salmon.

The designated EFH areas covered under these FMPs within the action area are shown in **Figure 1-3**.



Path: U:\GIS\GIS\Projects\2020xxx\D202006767_RussianRiver\Figures\Fig_3_EFH.mxd, GLeidy 11/30/2022

SOURCE: NMFS (2016)

RRBA

ESA

Figure 1-3
Essential Fish Habitat
Russian River Watershed

SECTION 2

Consultation to Date

2.1 Relevant Prior Consultation

A brief summary of the relevant consultation history that led to the issuance of the *2008 Biological Opinion* is provided below:

- NMFS, USACE, and Sonoma Water entered into a Memorandum of Understanding (MOU) on December 31, 1997. The purpose of the MOU was to establish a framework for a Section 7 consultation under the FESA for existing operations and actions carried out by USACE, Sonoma Water, and the MCRRFCD.

- After the MOU was signed in December 1997, the signatory agencies established an Executive Committee for the consultation, consisting of representatives of each of the signatory agencies, as well as representatives from the MCRRFCD and the CDFW. The Executive Committee has met regularly since 1998 and is responsible for all major shared policy decisions regarding the consultation.

- Recognizing the regional significance of the consultation to fish resources and the communities affected by changes in operations, and based on public interest in the consultation, the signatory agencies also established a Public Policy Facilitating Committee (PPFC) to provide updates to the public regarding the progress of the consultation, and to receive input from the public. Public participation is not required for a Section 7 interagency consultation under the FESA, but it was included in the Russian River Section 7 consultation by the Executive Committee. The Executive Committee also established an Agency Working Group for the consultation, which included representatives from Sonoma Water, USACE, NMFS, CDFW, MCRRFCD, and the North Coast Regional Water Quality Control Board (NCRWQCB). The Agency Working Group met regularly to discuss the analyses for the BA for the consultation.

- NMFS transmitted a draft biological opinion to the USACE and Sonoma Water on June 11, 2007. The draft biological opinion indicated that the operation and maintenance of the existing facilities were likely to jeopardize the species and adversely modify critical habitat for CCC Coho Salmon ESU and CCC steelhead DPS. NMFS did not provide any draft RPAs. Instead, NMFS invited the USACE and Sonoma Water to work collaboratively with NMFS on the development of project changes necessary to avoid jeopardy and adverse modification, and meet the other requirements of 50 CFR 402.14 (g)(5) and 402.02.

- NMFS received written comments from USACE on September 14, 2007, and from Sonoma Water on January 17, 2008. In October, November, and December of 2007, as well as January, February, and March of 2008, NMFS met with USACE and/or Sonoma Water to develop the components of a RPA to the Proposed Action.

- CDFW participated in the review of the June 11, 2007, draft biological opinion; CDFW also provided input in the development of the draft RPA for purposes of reaching a “consistency determination" that the project will be implemented consistent with the CESA. Work on the RPA was largely completed by early April 2008.

- During work on the RPA, USACE, Sonoma Water, and NMFS determined that a major component of the RPA would take up to fifteen years to complete. The remediation of project impacts to designated critical habitat in Dry Creek would take 12 to 15 years to accomplish. NMFS transmitted a working draft biological opinion to USACE and Sonoma Water on August 1, 2008, and indicated that the timeframe for analysis of the original Proposed Action would need to be changed from ten years to fifteen years. NMFS also indicated in transmitting the working draft that the RPA did not ensure that resulting project operations would not likely jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. Because the project's impact on critical habitat could not be fully addressed in a ten-year period, NMFS, USACE, and Sonoma Water agreed to amend the period of the Proposed Action from ten to fifteen years. The RPA's approaches to addressing impacts to critical habitat were also discussed between Sonoma Water, USACE, and NMFS and modified subsequent to the August 1, 2008, working draft.
- NMFS received additional comments on the working draft biological opinion from Sonoma Water and USACE on August 22, 2008. These comments were incorporated as appropriate, and a final biological opinion was issued by NMFS on September 24, 2008.

2.2 Consultation to Date

The following lists the formal communications and consultations to date between USACE, Sonoma Water, and the resource agencies regarding re-initiation of consultation:

- On April 28, 2021, Sonoma Water hosted an inter-agency meeting to re-initiate consultation on operations within the Russian River watershed. In addition to Sonoma Water and USACE staff, the meeting was attended by staff from NMFS and CDFW.
- On May 4, 2022, Sonoma Water provided an update on the *in progress* administrative draft BA at the annual PPFC meeting. Attendees included representatives from NMFS, CDFW, and USACE.
- On June 16, 2022, Sonoma Water hosted an inter-agency (Executive Committee) meeting to discuss implementation of the *2008 Biological Opinion* and describe the process and schedule for review of this BA. In addition to Sonoma Water and USACE staff, the meeting was attended by staff from NMFS and CDFW.
- On August 3, 2022, USACE and Sonoma Water met with representatives from NMFS and CDFW to discuss initial agency feedback on the Environmental Baseline portion of the administrative draft BA.
- On November 2, 2022, Sonoma Water and ESA provided an overview of the draft BA review process to agency representatives from NMFS and CDFW.
- On December 14, 2022, Sonoma Water and ESA met with agency representatives from NMFS and CDFW to receive initial feedback on the agency draft BA.

- Multiple resource agency meetings were held to discuss the various project elements contained in the draft BA. Attendees included representatives from NMFS, CDFW, and USACE. Specific meetings and the dates they occurred are listed below:
  - On January 4, 2023, Sonoma Water and ESA discussed flood control operations with agency representatives.
  - On January 11, 2023, Sonoma Water and ESA discussed water supply operations with agency representatives.
  - On January 18, 2023, Sonoma Water and ESA discussed estuary management with agency representatives.
  - On January 25, 2023, Sonoma Water and ESA discussed Dry Creek enhancement measures with agency representatives.
    - On February 2, 2023, Sonoma Water hosted a workshop to inform agency representatives on Dry Creek enhancement past actions and future proposed work.
  - On February 1, 2023, Sonoma Water and ESA discussed the monitoring program in the Russian River watershed with agency representatives.
  - On February 8, 2023, Sonoma Water and ESA discussed channel maintenance and Mirabel Dam operations with agency representatives.
    - On February 21, 2023, Sonoma Water hosted a workshop for agency representatives on Mirabel operations and Wohler pool operations; including presenting information on outmigrant survival and predation.
- On February 22, 2023, Sonoma Water and ESA provided an overview to agency representatives from NMFS and CDFW on the revisions made to the draft BA based on comments provided by these agencies and the project element discussions outlined above.
- On February 28, 2023, USACE sent a letter requesting initiation of formal consultation with NMFS pursuant to section 7 of FESA and on EFH under the EMSA for USACE’s and Sonoma Water’s Russian River Watershed Water Supply and Channel Maintenance Project. The letter included the final Russian River Biological Assessment and Essential Fish Habitat Assessment (RRBA) dated February 28, 2023.
- On April 4, 2023, NMFS sent a letter to USACE stating that the materials included in the consultation request did not provide all of the information necessary to initiate formal consultation under FESA, as described in the regulations governing interagency consultations, or to complete EFH consultation under the EMSA. The letter identified the additional information needed to initiate formal FESA consultation and to complete EMSA consultation with NMFS.

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SECTION 3

Description of the Proposed Action

3.1 Introduction

This section presents a description of the Proposed Action, including operations and maintenance activities associated with project facilities. **Table 3-1** provides a summary of project elements included in the Proposed Action and designates their status as ongoing, modified, and/or new operations and maintenance.

TABLE 3-1
SUMMARY OF PROJECT ELEMENTS INCLUDED IN THE PROPOSED ACTION AND STATUS

Proposed Action/Project Element	Summary Description and Status
Reservoir Flood Control Operations at Coyote Valley Dam (CVD) and Warm Springs Dam (WSD)	USACE is proposing ongoing (modified) flood control operations associated with *Planned Major Deviation* to the 1986 Lake Mendocino Water Control Manual (WCM) for Water Year (WY) 2021 through WY 2026, pending updates to the WCM, and application of forecast-informed reservoir operations (FIRO) procedures. Application of FIRO procedures will continue after the WCM has been updated. USACE is also proposing ongoing flood control operations at WSD consistent with the Lake Sonoma WCM, with future proposed modifications associated with application of FIRO procedures, which are currently in development.
Reservoir Water Supply Operations at CVD and WSD	Sonoma Water proposes an interim, seven-year change to its water-right permits in order to modify the hydrologic index to reflect conditions in the Russian River watershed as opposed to the current Decision 1610 index located in the Eel River watershed, and implement changes to Decision 1610 minimum flows consistent with the *2008 Biological Opinion* that calls for adjustments to the minimum flows for Normal and Dry hydrologic conditions, pending completion of permanent changes to Sonoma Water's water rights permits (see Fish Habitat Flows and Water Rights Project). Interim and permanent changes to Sonoma Water's water rights permits are intended to address current uncertainties associated with changes in operations of PG&E's PVP and its impact on water supply reliability in Lake Mendocino and the Russian River watershed.
Russian River Estuary Management	Sonoma Water is proposing modified management of the Estuary with the objectives of enhancing salmonid habitat in the Estuary while minimizing flood risk to low-lying properties adjacent to the Estuary.
Channel Maintenance on portions of the mainstem Russian River and Dry Creek	Sonoma Water and the Mendocino County Russian River Flood Control & Water Conservation and Improvement District (MCRRDC&WCID) propose limited channel maintenance on portions of Dry Creek, specifically maintenance of facilities associated with CVD and WSD operations.[11]
Central Sonoma Watershed Project flood control facilities operations	Sonoma Water proposes ongoing passive operations of Central Sonoma Watershed Project flood control facilities including recently constructed bypass pipe at the Santa Rosa Creek diversion structure.

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[11] Channel maintenance actions on the Russian River will be undertaken solely by the Mendocino County Russian River Flood Control & Water Conservation and Improvement District. Sonoma Water channel maintenance will be limited to Dry Creek.

TABLE 3-2
SUMMARY OF PROJECT ELEMENTS INCLUDED IN THE PROPOSED ACTION AND STATUS

Proposed Action/Project Element	Summary Description and Status
Coyote Valley Fish Facility (CVFF) and Don Clausen Fish Hatchery (DCFH) Facilities Maintenance	USACE proposes ongoing maintenance of facilities at CVFF and DCFH. However, hatchery management activities will be managed consistent with HGMPs, each with their own, separate FESA coverage; therefore, management is not included as part of this Proposed Action.
Dry Creek Habitat Enhancements	Sonoma Water and USACE propose ongoing monitoring and maintenance of Dry Creek enhancement projects and new enhancement actions that are currently in the planning phase.
Physical and Biological Monitoring (Russian River watershed)	Sonoma Water and USACE propose modified physical and biological monitoring in the Russian River watershed associated with current and proposed monitoring needs.

Hydroelectric project operations at CVD and WSD, hatchery management at CVFF (at CVD), and DCFH (at WSD), and SMP activities were included as part of the Proposed Action in the *2008 Biological Opinion*; however, these activities currently have their own FESA coverage through separate processes and consultations. As a result, they are not included as part of the Proposed Action in this consultation. Additional details on these activities are provided in Section 4, *Environmental Baseline*.

3.2 Reservoir Operations

This section discusses future reservoir management by USACE and Sonoma Water including proposed changes to flood control and water supply operations. Two major reservoirs provide flood control and water supply storage for the Russian River basin: Lake Mendocino and Lake Sonoma. USACE and Sonoma Water are the federal and local sponsors, respectively, for both CVD at Lake Mendocino and WSD at Lake Sonoma. The USACE has responsibility for reservoir operations when the reservoirs are within their flood pool, a period referred to as flood control operations. Sonoma Water has responsibility for reservoir operations when the reservoirs are in their conservation pool (i.e., when the water surface elevation is below the flood pool elevation); a period referred to as water supply operations. The rate at which water is released from the reservoirs, either for flood control or for water supply, has implications for both physical and biological resources downstream of the dams. Background on the water operations facilities, including a description of historical reservoir and water supply operations is provided under Section 4, *Environmental Baseline.*

The *2008 Biological Opinion* developed a series of RPAs and Reasonable and Prudent Measures (RPMs) designed to mitigate the effects of reservoir operations on salmonids and their habitat. A brief summary of historical reservoir operations at the time of issuance of the *2008 Biological Opinion*, a description of the relevant RPAs and RPMs, and the operational adjustments undertaken in response are also described when relevant to current operations. Importantly, since the *2008 Biological Opinion* was issued, several of the recommendations contained in the RPAs and RPMs have been modified or refined in response to new information and other developments, some of which are incorporated into the Proposed Action. A complete discussion on the implementation of the *2008 Biological Opinion* RPAs and RPMs is provided in Section 4, *Environmental Baseline*.

Many reservoir operational procedures will continue in a manner consistent with those prescribed in their respective Water Control Manuals (WCMs) and the *2008 Biological Opinion*, however, modifications to flood control and water supply operations are proposed for implementation. Specifically, implementation of Forecast Informed Reservoir Operations (FIRO) at Lake Mendocino, and in the future, Lake Sonoma, will result in revisions to flood control operations at those facilities. Similarly, implementation of water right permits interim change petitions, and eventually, the Fish Flow Project would change minimum instream flow requirements in a manner designed to improve rearing habitat for salmonids. These changes to flood control and water supply operations, included as part of the Proposed Action, are discussed below.

3.2.1 Flood Control Operations

Flood control operations included as part of the Proposed Action are described separately below for CVD and WSD. All flood control releases from Lake Mendocino and Lake Sonoma are constrained by the need to reduce flood risk downstream within the Russian River watershed. During periods of high rainfall-runoff, storage increases at each lake. If within the flood control pool, and conditions downstream permit, water is required to be released from both reservoirs to restore storage space for the next event. Within the FIRO flood control pool, weather forecasts can enable a decision to continue to retain water and/or influence the rate of flood control release required to sustain flood risk management obligations. In this FIRO flood control pool, ramping rates can be considered while formulating a decision based on FIRO principles. For all flood control releases above the FIRO flood control pool, USACE will accommodate desired ramping rates to the extent possible without impacting flood risk management obligations.

Flood control operations at CVD and WSD include both non-discretionary and discretionary federal actions. Non-discretionary actions are those activities that are required to maintain Civil Works structures so that they continue to serve their Congressionally authorized purposes and are inherent in the authority to construct them. Non-discretionary federal actions at CVD and WSD include dam security and enforcement, dam safety inspections, implementation of the WCM (not including discretionary deviations to the WCM with application of FIRO procedures), annual pre-flood inspections, and periodic five-year inspections. Discretionary actions at CVD and WSD include deviations to the WCM with application of FIRO procedures. USACE has also proposed discretionary (voluntary) conservation measures to avoid and minimize potential adverse effects at CVD and WSD, which include minimum flows and ramping rates associated with annual pre-flood inspections and periodic five-year inspections (non-discretionary activities) (see Section 3.10, *Conservation Measures*, below).

A description of non-discretionary and discretionary actions at CVD and WSD, including rationale for determinations, is provided in **Appendix A**, Non-Discretionary and Discretionary Federal Actions at Coyote Valley Dam and Warm Springs Dam.

3.2.1.1 Coyote Valley Dam

Flood control releases under the Proposed Action would be made in accordance with the *Planned Major Deviation* (Deviation) to the 1986 Lake Mendocino WCM for water year (WY) 2021 through WY 2026.[12] USACE approved the Deviation and is currently developing an update to the 1986 Lake Mendocino WCM (to be completed in fall 2024) to reflect the operations that are allowed by the Deviation. The Deviation began in 2021 and extends through 2026, after which flood control releases would be made in accordance with the updated WCM. Under the Proposed Action, storage of Lake Mendocino will reach a maximum of 80,050 acre-feet during the flood season, between November 1 and February 15, which represents an increase of 11,650 acre-feet compared to the amount prescribed in the current WCM. After February 15, the FIRO pool increases by approximately 355 acre-feet per day until May 12 when it intersects the guide curve for a maximum storage of 111,000 acre-feet. Storage in the flood control space up to 80,050 acre-feet would be guided by procedures identified as part of FIRO.

FIRO is a flexible water management approach that uses data from watershed monitoring and improved weather forecasting to help reservoir operators selectively retain or release water from reservoirs for increased resilience to droughts and floods. FIRO applies emerging science and technology to optimize water resources and adapt to climate change without costly infrastructure. Without FIRO, reservoir operators are forced to evacuate flood control space when downstream conditions permit, regardless of future weather forecasts. Under FIRO, reservoir operators can adaptively retain or release water based on available weather forecasting within downstream operating constraints. Storage in the flood control space above the top of the FIRO space would be released according to the constraints defined in the WCM. The goal of the Deviation and application of FIRO procedures at Lake Mendocino was to update the 1950s-era WCM by applying precipitation forecasting advancements to increase water supply reliability without reducing the existing flood protection capacity of Lake Mendocino.

Since flooding and water supply in the Russian River basin are driven almost entirely by atmospheric rivers (ARs) the success of FIRO at Lake Mendocino depends on research to improve AR forecasts. A large body of work, led by the Center for Western Weather and Water Extremes (CW3E) at Scripps Institution of Oceanography, has enabled FIRO at Lake Mendocino. CW3E's work includes the AR Reconnaissance program, which fills major gaps in observations over the ocean to improve the accuracy of forecast models.[13] USACE utilized the FIRO tools with planned major deviations from the WCM during WYs 2019 and 2020. In both years, FIRO increased water supply benefits and managed flood risks. In 2020, FIRO increased water storage by nearly 20 percent (%), roughly equivalent to the water used by 22,000 households.

USACE's decision to approve the Deviation and to subsequently pursue an update to the CVD WCM was based on a collaborative process between members of the FIRO Steering Committee

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[12] Sonoma Water. 2020. Water Year 2021 – 2026 Major Planned Deviation to the Coyote Valley Dam-Lake Mendocino Water Control Manual Draft Environmental Assessment. October 2020.

[13] Jasperse, J., Ralph, F. M., Anderson, M., Brekke, L., Malasavage, N., Dettinger, M. D., Forbis, J., Fuller, J., Talbot, C., Webb, R., & Haynes, A. 2020. Lake Mendocino Forecast Informed Reservoir Operations. Final Viability Assessment. UC San Diego.

under which FIRO procedures were tested in real-time during WY 2019 and WY 2020.[14] Under the trial, FIRO allowed for safe management of the reservoir during a wet year (WY 2019), as weather forecasting indicated the need to have flood control space available for rainfall-runoff in January and February. During the following dry year (WY 2020), management under FIRO allowed water to be retained when weather forecasts indicated no significant rainfall-runoff events for the months of February and March. Taken together, these findings form the basis of flood control releases under which the Proposed Action would be made in accordance with the Deviation.

Flood control flow ramping rates and dam inspection flows for CVD are included as voluntary conservation measures (see Section 3.10, *Conservation Measures*, below).

3.2.1.2 Warm Springs Dam

Under the Proposed Action, USACE will continue to manage water releases at Lake Sonoma when the water levels rise above the top of the water supply pool (451.1 feet above mean sea level [MSL]) and into the flood control pool. USACE will also manage releases during annual inspections and during maintenance and repairs. Sonoma Water will continue to manage releases at Lake Sonoma made from the water supply pool.

Flood control operations at WSD will proceed according to procedures set out in the WSD WCM.[15] However, USACE and the Russian River FIRO Steering Committee are also currently evaluating FIRO alternatives that would be applied at Lake Sonoma. Potential proposed changes with respect to flood control operations for Lake Sonoma are still to be determined; however, any revisions will comply with minimum instream flow requirements in place at the time FIRO procedures are developed for WSD. This includes flood control release requirements that stipulate that such releases would be minimized when flows on the Russian River near Guerneville are greater than 35,000 cfs. Minor deviation being considered for storage in Lake Sonoma includes a maximum FIRO pool of 254,500 ac-ft during the flood season. After February 15, the FIRO pool would increase by approximately 633 acre-feet per day until March 1, when it reaches a maximum summer storage of 265,000 acre-feet. Under the Proposed Action, it is anticipated that weather forecasting tools similar to those used under FIRO at Lake Mendocino will be utilized at Lake Sonoma. Development of these tools and any subsequent proposed changes in operations at WSD would be conducted in close coordination with NMFS and CDFW.

Flood control flow ramping rates and dam inspection flows for WSD are included as voluntary conservation measures (see Section 3.10, *Conservation Measures*, below).

3.2.2 Water Supply Operations

Sonoma Water's water supply operations at the time the *2008 Biological Opinion* are summarized in Section 4*, Environmental Baseline*. The findings and recommendations of the *2008 Biological*

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[14] Appendix C in Sonoma Water. 2020. Water Year 2021 – 2026 Major Planned Deviation to the Coyote Valley Dam-Lake Mendocino Water Control Manual Draft Environmental Assessment. October 2020.

[15] USACE, 1984. Warm Springs Dam and Lake Sonoma, Dry Creek, California: Water Control Manual. Appendix II to the Master Water Control Manual, Russian River Basin. September 1984.

Opinion are included within the context of each component of proposed water supply operations, where relevant.

As described above, Sonoma Water is the local sponsor for Lake Mendocino and Lake Sonoma and is responsible for making water supply releases in compliance with its water rights permits issued by the SWRCB. As the local sponsor, Sonoma Water has the exclusive right to control releases from the water supply pools at each reservoir. Sonoma Water makes releases from CVD to maintain the minimum instream flow requirements specified in its water right permits and for downstream beneficial uses along the Upper Russian River,[16] including diversions for domestic, municipal, industrial, and agricultural purposes. These releases are made by Sonoma Water when reservoir storage levels are in the water supply pool (also known as the water conservation pool), which is at or below the reservoir guide curve as established in the CVD WCM. Sonoma Water makes release decisions from CVD for the Upper Russian River to comply with minimum instream flow requirements in its water right permits at compliance locations between Healdsburg and the confluence of the West and East Forks of the Russian River. It should be noted that Healdsburg is over 96 kilometers (km) downstream of Lake Mendocino. Sonoma Water makes releases from WSD to maintain the minimum instream flow requirements in Dry Creek and the Lower Russian River specified in its water right permits and for downstream beneficial uses, including diversions for municipal, domestic, and industrial purposes. These releases are made by Sonoma Water when reservoir storage levels are in the water supply pool, which is at or below the reservoir guide curve as established in the WSD WCM. While Sonoma Water must release enough water to satisfy diversions and stream depletions that occur along Dry Creek and the Russian River plus the amount needed for minimum instream flow compliance, Sonoma Water does not control these diversions and the streamflow loss due to diversions and depletions can only be estimated from stream gage information at the compliance locations.

3.2.2.1 Proposed Interim Seven-year Petitions to Decision 1610

As described in Section 4, *Environmental Baseline*, changes in operations of Pacific Gas & Electric’s (PG&E’s) Potter Valley Project (PVP) and its impact on water supply reliability in Lake Mendocino and the Russian River watershed, the ongoing uncertainty regarding future transfers of water from the Eel River watershed through the PVP, and ongoing variable hydrologic conditions challenge ongoing and future water supply reliability. Several actions to address these uncertainties and improve water supply reliability in the Russian River watershed will be proposed as part of the interim, seven-year petition to amend Sonoma Water’s water rights permits.

Proposed Interim Water-Rights Petition Hydrologic Index

Sonoma Water proposes an interim, seven-year change to its water-right permits in order to modify the hydrologic index to reflect hydrologic conditions in the Russian River watershed as opposed to the current SWRCB’s Decision 1610 index located in the Eel River watershed (based on cumulative inflow into Lake Pillsbury) (see **Appendix B** for full description of the proposed Interim Water Rights Petition Hydrologic Index), and implement revised minimum instream flows consistent with those outlined in the *2008 Biological Opinion*.

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[16] Upper Russian River is defined as the Russian River between the East Fork Russian River and Dry Creek.

This interim change would align the applicable streamflow requirements with the Russian River watershed's hydrology pending completion of permanent changes to Sonoma Water's water rights permits (see discussion on Fish Habitat Flows and Water Rights Project (Fish Flow Project) below and in Section 4, *Environmental Baseline*). This interim change would move the hydrologic index from Lake Pillsbury in the Eel River watershed to Lake Mendocino in the Russian River watershed, account for operational changes at PG&E's PVP (see below), and implement changes to Decision 1610 minimum flows consistent with the *2008 Biological Opinion* that calls for adjustments to the minimum flows for Normal and Dry hydrologic conditions.

Proposed Interim Water Rights Minimum Instream Flows

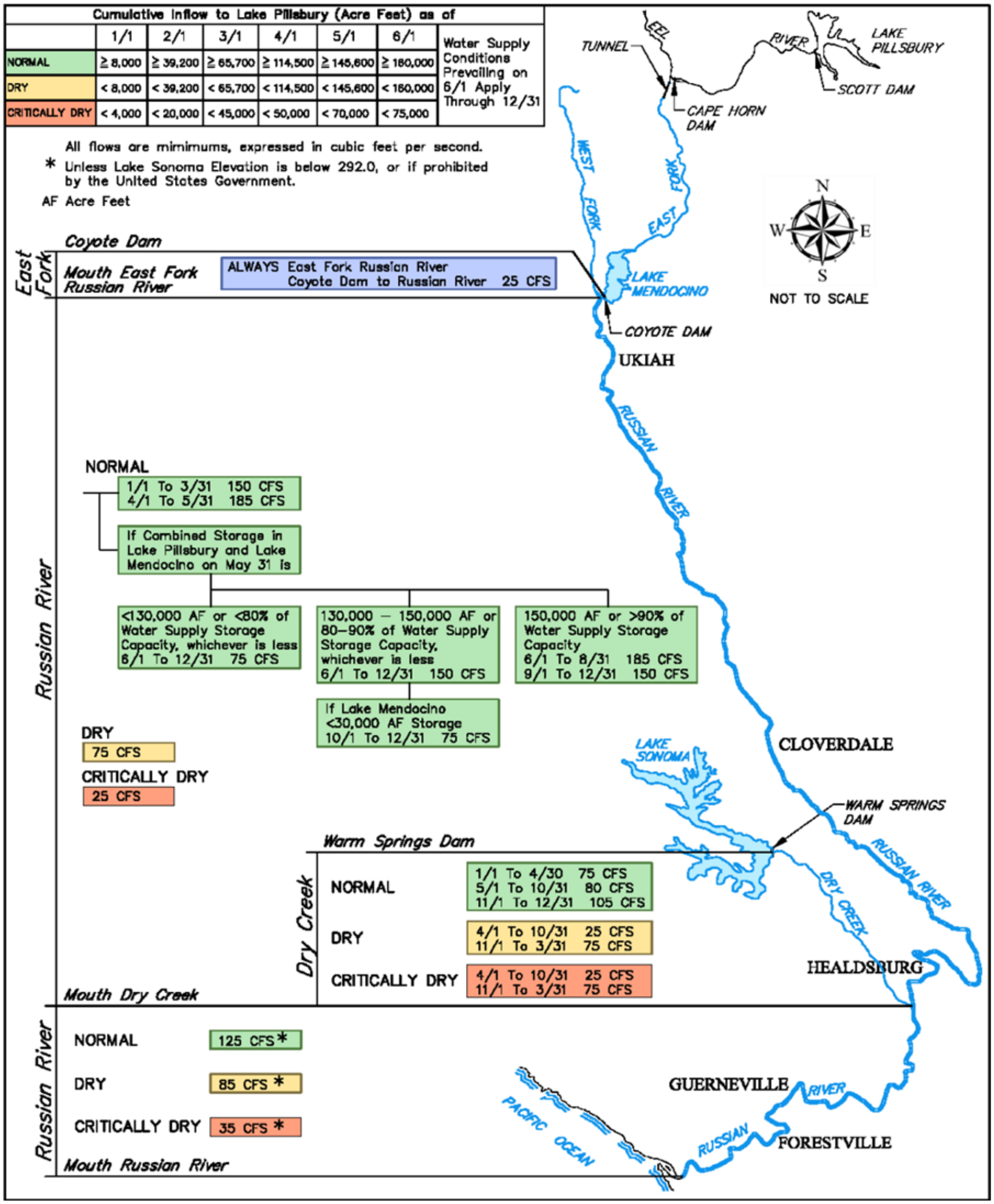
The *2008 Biological Opinion* determined that the assumptions governing the minimum instream flow requirements as established in Decision 1610 were no longer appropriate (see **Figure 3-1** for Decision 1610 minimum instream flow requirements). Decision 1610 assumed that higher instream flows would result in improved conditions for fish resources, however, subsequent studies within the Russian River and Dry Creek indicated that higher flows were not always beneficial to salmonids.

The *2008 Biological Opinion* concluded that:

> *"…continued operations of Coyote Valley Dam and Warm Springs Dam by the USACE and Sonoma Water in a manner similar to recent historic practices were likely to jeopardize and adversely modify the critical habitats of endangered Central California Coast Coho Salmon and threatened Central California Coast steelhead."* (p. xvi)

Specifically, NMFS determined that artificially elevated summertime minimum flows resulted in high water velocities. These elevated velocities led to reductions in the quality and quantity of rearing habitat for Coho Salmon and steelhead. Additionally, NMFS concluded that maintaining these flows disrupts lagoon formation in the Russian River Estuary and therefore impairs juvenile salmonid rearing habitat. To address these concerns, the *2008 Biological Opinion* provided an RPA that included options to pursue changes to Decision 1610 to reduce minimum flows in the Russian River and Dry Creek between late spring and early fall via Sonoma Water filing TUCPs with the SWRCB.

In order to address these findings, Sonoma Water will propose the following changes to Decision 1610 minimum flows, consistent with the *2008 Biological Opinion*, as part of the interim water-rights petition:



	Cumulative Inflow to Lake Pillsbury (Acre Feet) as of						
	1/1	2/1	3/1	4/1	5/1	6/1	Water Supply Conditions Prevailing on 6/1 Apply Through 12/31
NORMAL	≥ 8,000	≥ 39,200	≥ 65,700	≥ 114,500	≥ 145,600	≥ 180,000	
DRY	< 8,000	< 39,200	< 65,700	< 114,500	< 145,600	< 180,000	
CRITICALLY DRY	< 4,000	< 20,000	< 45,000	< 50,000	< 70,000	< 75,000	

All flows are mimimums, expressed in cubic feet per second.

* Unless Lake Sonoma Elevation is below 292.0, or if prohibited by the United States Government.

AF Acre Feet

Source: NMFS 2008

Figure 3-1
Decision 1610 Minimum Instream Flows

During Normal Years:

- Reduce the minimum flow requirement between the mouth of Dry Creek and the mouth of the Russian River from 125 cfs to 70 cfs.
- Reduce the minimum flow requirement in the Russian River from the East Fork to Dry Creek from 185 cfs to 125 cfs between June 1 and August 31; and from 150 cfs to 125 cfs between September 1 and October 31.
- Reduce the minimum flow requirement in Dry Creek from Warm Springs Dam to the Russian River from 80 cfs to 40 cfs from May 1 to October 31.

During Dry Years:

- Reduce the minimum flow requirement between the mouth of Dry Creek and the mouth of the Russian River from 85 cfs to 70 cfs.

During the time of this proposed seven-year interim change, Sonoma Water will revise the draft Environmental Impact Report (EIR) for the Fish Flow Project that was circulated for public review and comment in 2016. A critical element of the work to prepare a revised draft EIR will be development of modeling scenarios that reflect reasonably foreseeable likely future PVP operations. By 1986, the PVP annually had imported, for decades, significant amounts of water diverted from the Eel River watershed to the Russian River watershed that averaged approximately 156,000 acre-feet annually. Subsequent to an amendment to PG&E’s PVP operating license in the mid-2000s, the average annual transfer declined to approximately 62,000 acre-feet annually. In 2021, PG&E reported that the transformer bank at the PVP powerhouse had failed and will require replacement. This resulted in further reduction to imports of Eel River water to the Russian River watershed. On May 11, 2022, the Federal Energy Regulatory Commission (FERC) directed PG&E to propose a schedule for filing a surrender application and decommissioning plan for the PVP. On July 8, 2022, PG&E submitted a plan and schedule to FERC to surrender its license. FERC approved PG&E’s schedule and plan on July 29, 2022. Furthermore, in March 2023, PG&E informed FERC that it will no longer close the spillway gates on Scott Dam in the spring due to seismic concerns of the dam and would not repair or replace the transformer. This reduced the total storage capacity of Lake Pillsbury from approximately 77,000 acre-feet to approximately 56,000 acre-feet. The reduction in storage capacity going into the summer season has required PG&E to request flow variances to reduce releases from Scott Dam in order to manage the reservoirs cold water pool. Cold water releases are essential for supporting habitat for salmon and steelhead that rear downstream of Scott Dam in the late summer and early fall.

Per FERC’s approved schedule, PG&E will submit a final license surrender application and decommissioning plan by January 29, 2025. FERC’s license-surrender proceedings will likely take at least several years. Long-term PVP operations, and therefore imports to the Russian River watershed, may not be resolved for more than five years from now.

This element of the Proposed Action will allow Sonoma Water to respond to changes in Russian River watershed conditions resulting from changes to PVP operations during the course of the environmental baseline in a manner that provides for improved reliability of water supply for beneficial uses, including maintaining storage in the reservoirs and the cold water pool in Lake Mendocino in the near-term, while continuing to pursue permanent changes in water rights that will appropriately address future uncertainties in PVP operations that will impact reliability of water supply and associated beneficial uses in the Russian River watershed.

3.2.2.2 Preliminary Fish Flow Project Water Supply Releases and Minimum Instream Flows

As described above, the *2008 Biological Opinion* also indicated that Sonoma Water may develop an alternative minimum instream flow schedule that improves conditions for threatened and endangered salmonids within the Russian River watershed. Furthermore, the *2008 Biological Opinion*'s RPA includes a multiyear process for changing Decision 1610 involving filing a Petition to Change Decision 1610 with the SWRCB, posting Public Notice of this Petition, completing a multiyear EIR for California Environmental Quality Act (CEQA) compliance, and taking part in a hearing process before the SWRCB.

To that end, Sonoma Water is developing revisions to the Fish Flow Project (draft circulated for public review and comment in 2016). Specific flow schedules and associated indices are subject to future revision based on ongoing discussions between Sonoma Water, USACE, and resource agencies, including NMFS, and may be modified through preparation of the recirculated Draft EIR in response to public and resource agency comments received on the Draft EIR, and revisions based on development of modeling scenarios that reflect reasonably foreseeable likely future PVP operations. Further, it is acknowledged that continued coordination and consultation with NMFS will be required to ensure that any proposed changes comply with FESA requirements, including the potential for triggering reinitiation of consultation. As a result, they are identified as preliminary for purposes of this BA.

The preliminary proposed changes to minimum instream flow requirements contained within the Fish Flow Project are based on a rigorous analysis of Russian River hydrology and were developed to improve conditions for threatened and endangered salmonids. As part of the Proposed Action, the Fish Flow Project will permanently change minimum instream flow requirements in Sonoma Water's water right permits in a manner that will improve conditions for threatened and endangered salmonids, add additional authorized points of diversion, change the hydrologic index from cumulative inflow into Lake Pillsbury (located in the Eel River watershed) to storage/inflow conditions at Lake Mendocino, and extend the deadlines for applying the existing water right to full beneficial use. The preliminary proposed changes are the result of ongoing efforts by Sonoma Water in response to the findings and directives of the *2008 Biological Opinion* and are designed to be protective of habitat conditions for threatened and endangered salmonids.

The Fish Flow Project includes five preliminary proposed components:[17]

- Amendments to Sonoma Water's water right permits to replace the existing hydrologic index with a new Russian River Hydrologic Index that more accurately reflects hydrologic conditions within the Russian River watershed (the Decision 1610 Hydrologic Index, which relies on conditions in Lake Pillsbury in the Eel River watershed, is currently the metric used

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[17] SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

to determine the applicable minimum instream flow schedule for the upper and lower Russian River and Dry Creek);

- Changes to the minimum instream flow requirements in these permits to improve rearing habitat conditions for juvenile steelhead in the upper Russian River and for juvenile steelhead and Coho Salmon in Dry Creek;
- Changes to the minimum instream flow requirements to improve conditions for fall-run Chinook Salmon migration;
- Extending the deadlines for completing full beneficial use of existing water rights in these permits to December 31, 2040; and
- Adding the Occidental Community Services District and Town of Windsor points of diversion and re-diversion to the authorized points of diversion in these permits.

Under the preliminary proposed Fish Flow Project, the Decision 1610 Hydrologic Index would be replaced with a Russian River Hydrologic Index; comprised of five distinct minimum instream flow schedules derived from the hydrologic year type within the Russian River watershed. The preliminary proposed Russian River Hydrologic Index is a five-schedule index (5 schedules of minimum instream flow requirements as opposed to the existing 3 schedule hydrologic index specified in Decision 1610). The minimum instream flow schedules (Flow Schedules) are defined as Schedule 1, Schedule 2, Schedule 3, Schedule 4, and Schedule 5; with Schedule 1 being the wettest Flow Schedule and Schedule 5 being the driest.

Under the preliminary proposed index, Flow Schedules for the lower Russian River and Dry Creek will be determined by cumulative inflow into Lake Mendocino (Inflow Condition) beginning on October 1 of the previous year and evaluated on the first of the month from January 1 to October 1 against a series of cumulative inflow thresholds. The Flow Schedule set by the October 1 evaluation will remain in effect for the remainder of the calendar year. Flow Schedules for the upper Russian River will be determined by Inflow Condition from January 1 to May 31 and beginning on June 1 to December 31, the preliminary proposed index will evaluate Lake Mendocino storage levels (Storage Condition) against a series of storage thresholds. On the first day of the month from June 1 to December 1 the combination of Storage Condition and Inflow Condition will be used to determine Flow Schedules for the upper Russian River. For the evaluation dates from June 1 to September 1, if the Storage Condition exceeds the Inflow Condition, then the Flow Schedule is increased to a maximum of one schedule greater than the Inflow Condition. For the evaluation dates from October 1 to December 1, if the Storage Condition exceeds the Inflow Condition by greater than one schedule then the upper Russian River Flow Schedule may be greater than Inflow Condition but can only change at a rate of one schedule per month. The preliminary proposed Fish Flow Project Russian River Hydrologic Index is shown graphically in **Figure 3-2**.

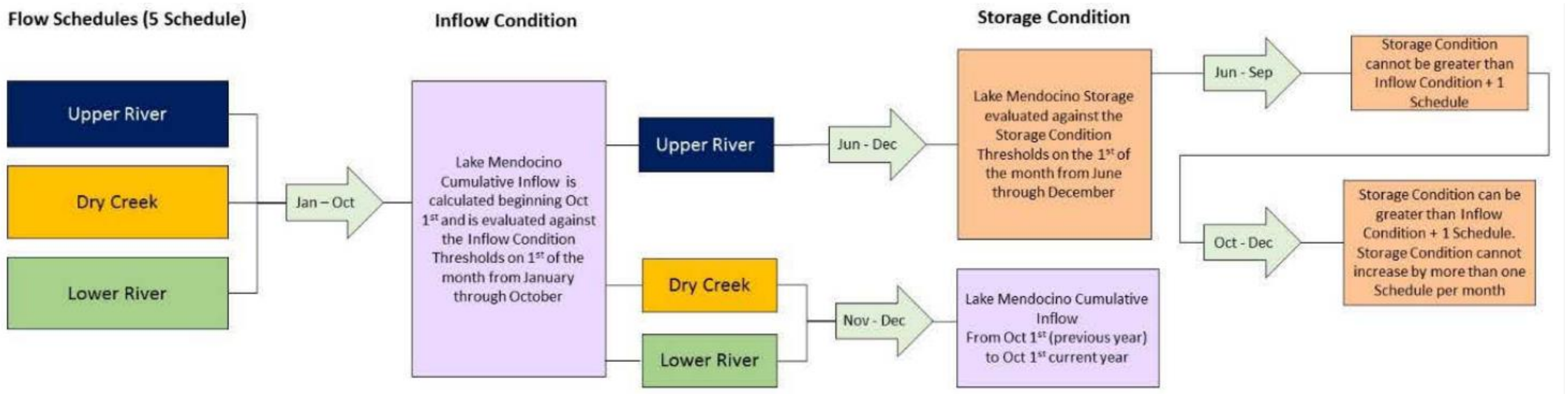

Figure 3-2
Preliminary Proposed Fish Flow Project Russian River Hydrologic Index

An increase from three to five flow schedules would allow for a more responsive management of reservoir water storage. This is particularly true at Lake Mendocino during the summer and fall months, when preserving cold water to benefit rearing steelhead and migrating Chinook Salmon in the upper Russian River is crucial. The revised schedule will also allow for smaller, incremental reductions in minimum instream flows; principally in the upper Russian River if reservoir storage levels are reduced due to lower inflow. As described in the Draft EIR released in 2016, preliminary proposed instream flows schedules are summarized below in **Tables 3-2** through **3-4**.

TABLE 3-2
PRELIMINARY PROPOSED FISH FLOW PROJECT UPPER RUSSIAN RIVER MINIMUM INSTREAM FLOW SCHEDULE (CFS)

Flow Schedule	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
1 (wettest)	105	105	105	105	105	105	105	105	105	105	105	105	105
2	105	105	105	105	85	85	85	85	85	85	105	105	105
3	100	100	100	100	65	65	65	65	65	65	100	100	100
4	70	70	70	70	45	45	45	45	45	45	45	70	70
5 (driest)	25	25	25	25	25	25	25	25	25	25	25	25	25

NOTE: Upper Russian River refers to the reach between the East Fork and confluence with Dry Creek

[a] At all times minimum instream flow must equal 25 cfs

SOURCE: SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

TABLE 3-3
PRELIMINARY PROPOSED FISH FLOW PROJECT LOWER RUSSIAN RIVER MINIMUM INSTREAM FLOW SCHEDULE (CFS)

Flow Schedule	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
1 (wettest)	135	135	135	135	70	70	70	70	70	70	135	135	135
2	135	135	135	135	70	70	70	70	70	70	135	135	135
3	135	135	135	135	70	70	70	70	70	70	135	135	135
4	85	85	85	85	50	50	50	50	50	50	85	85	85
5 (driest)	35	35	35	35	35	35	35	35	35	35	35	35	35

NOTE: Lower Russian River refers to the reach between the Russian River confluence with Dry Creek to the Pacific Ocean.

SOURCE: SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

TABLE 3-4
PRELIMINARY PROPOSED FISH FLOW PROJECT DRY CREEK MINIMUM INSTREAM FLOW SCHEDULE (CFS)

Flow Schedule	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
1 (wettest)	75	75	75	75	50	50	50	50	50	50	105	105	105
2	75	75	75	75	50	50	50	50	50	50	105	105	105
3	75	75	75	50	50	50	50	50	50	50	75	75	75
4	75	75	75	50	50	50	50	50	50	50	75	75	75
5 (driest)	75	75	75	50	50	50	50	50	50	50	75	75	75

NOTE: Reach of Dry Creek from Warm Springs Dam to its confluence with the Russian River

SOURCE: SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

3.2.2.3 Water Supply Operations Ramping Rates for Coyote Valley Dam and Warm Springs Dam

With respect to the non-flood water supply operations, under the Proposed Action, there will be no change to current operations and ramping rates will continue to be at maximum be 12 cfs/hour and no more than 24 cfs/day to minimize effects on adult and juvenile salmonids downstream of WSD and CVD (**Table 3-5**).

TABLE 3-5
RAMPING RATES DURING WATER SUPPLY OPERATIONS

Ramping Rate	Applicable Date Range
12 cfs/hour and no more than 24 cfs/day	During Water Supply Operations

SOURCE: NMFS, 2008. Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River Watershed.

If flow reductions of 12 cfs per hour or 24 cfs per day are made, Sonoma Water shall conduct an in-stream survey on the East Fork Russian River below the fish ladder to the Coyote Valley Fish Facility downstream to the confluence of the Mainstem Russian River and note any regions of the stream that are disconnected or any areas of isolated pools. Sonoma Water shall provide locations of disconnection and isolated pools to CDFW and NMFS on the following business day.

3.2.2.4 Lake Mendocino Turbidity Management

Elevated levels of turbidity remain a persistent condition in Lake Mendocino and in reaches of the Russian River downstream. Earlier efforts by USACE attempted to analyze turbidity levels and potential impacts at a series of sampling stations downstream of the reservoir, but the need for additional information such as Russian River-specific flow-turbidity and turbidity-suspended sediment rating curves has become apparent.

Turbidity Technical Advisory Committee

To determine mitigation actions for elevated turbidity levels, USACE has formed a technical advisory committee (TAC) including fishery biologists and water quality specialists. The TAC has been charged with both better defining the magnitude of the problem specifically as it affects ESA-listed species and advising USACE on potential solutions. The problem to be addressed will focus on reducing measurable turbidity effects to ESA-listed salmonids to acceptable levels. Defining what these acceptable levels are will be necessary to determine when a solution has been successfully implemented. The USACE identified initial TAC members from NMFS, CDFW, and the North Coast RWQCB and held a TAC kickoff meeting in February 2023 and a second meeting in July 2023. The USACE presented some initial discussion topics (e.g., problem definition, acceptable turbidity targets, the concept of "baseline" turbidity, etc.) to the TAC and drafted a Memorandum of Understanding (MOU) for the TAC. However, USACE now anticipates that the TAC will utilize an existing MOU involving these same agencies.

By September 23, 2023, USACE will issue a final turbidity report analyzing the collected turbidity data collected at Gauge Numbers 11461000 (West Fork, Ukiah at Lake Mendocino Drive Bridge), 11461500 (East Fork, Calpella), 11462000 (East Fork Russian River downstream of Coyote Valley Dam), 114625000 (Hopland), 1146382 (Jimtown), 11465240 (Dry Creek at Lambert Bridge) and transmit the final turbidity report to the TAC. Additionally, USACE will enlist the assistance of two TAC-approved peer reviewers of TAC recommendations and products who have expertise with turbidity and/or suspended sediment dynamics in reservoirs and rivers impacted by dams. Additional description of anticipated TAC activities is included below.

Turbidity Monitoring

The USACE will conduct turbidity monitoring at the following sites:

1. East Fork Russian River downstream of Coyote Valley Dam (Gauge No. 11462000), continuously by August 31, 2023;
2. Dry Creek downstream of Warm Springs Dam (Gauge No. 11465000), continuously by August 31, 2023; and
3. West Fork Russian River at Lake Mendocino Drive Bridge (Gauge No. 11461000), intermittently by October 15, 2023, and continuously by December 31, 2023.

The USACE has proposed conducting turbidity monitoring at the following two additional sites:

1. Lake Mendocino; in the thalweg with data collection at 20-foot intervals and at 5 feet off the bottom; and
2. The mainstem Russian River at Talmage, at or near USGS gauge (Gauge No. 11462080), if a cooperative agreement can be reached with USGS and private landowner(s).

The TAC has been apprised of the proposed monitoring locations and given the opportunity to suggest alternative locations for (4) and (5). The USACE will document the status of all turbidity monitoring by September 23, 2023. Turbidity monitoring is expected to begin at the last two sites or alternatives by December 31, 2023, pending any necessary agreements or permit requirements.

Additionally, USGS collects daily discharge, temperature, and turbidity data at two other locations of interest:

1. East Fork Russian River approximately 1 mile upstream of Lake Mendocino near Calpella (Gauge No. 11461500); and
2. Mainstem Russian River mainstem approximately 13 miles downstream of CVD near Hopland (Gauge No. 11462500).

The USACE will summarize the turbidity data from the above seven locations by water year (i.e., from October 1 through September 30) and present it in an annual report submitted on the following December 31 to the TAC and NMFS for review. The USACE plans to submit the initial annual report on December 31, 2024, and continue the submittals for a minimum of five years. Should an extension of the December 31 deadline be necessary in any given year, a request for the extension will be submitted to NMFS in writing with a justification one week prior to the deadline.

Short-term Implementation Actions

To avoid or minimize impacts to ESA-listed salmonids, USACE proposes to relate flow inputs to Lake Mendocino, release ramping rates, Tainter gate positions, etc. to turbidity measurements at the CVD outlet in an effort to determine operational scenario(s) that minimize the release of turbidity to the Russian River. Some flexibility in ramping rates is anticipated. The "best" operational scenario(s) will be determined and implemented within the constraints of the CVD WCM and O&M manual. USACE will meet with the TAC to plan these activities and review existing data within 1 year of the date of the biological opinion.

The following activities are proposed to better define the turbidity issues related to releases from CVD, including:

- Develop flow-turbidity curves, turbidity-suspended sediment curves, or other appropriate rating curves specifically for the Russian River;
- Develop and refine a conceptual model for the processes leading to both episodic and chronic turbidity impacts;
- Model sediment distribution and transport in Lake Mendocino and how they relate to the design and operation of the Dam outlet infrastructure; and
- Increase understanding of turbidity dynamics in the Russian River, including organic versus inorganic material.

USACE anticipates that the research to develop the rating curves will be conducted by a university graduate student, and that modeling will be conducted by the USACE Engineering Research and Development Center. USACE will present draft scopes of work, proposals, etc. for this work to the TAC for review and comment within 1 year of the date of the biological opinion. Due to the lead time required for approval and funding of these efforts, USACE expects the work to begin approximately three years from the date of the biological opinion. Results will be presented to the TAC for use in assessing the proposed solutions to the turbidity problem, below.

Long-term Implementation Actions

Potential solutions proposed by NMFS and others for reducing turbidity in and downstream from Lake Mendocino include the following:

- Dredge Lake Mendocino, including using targeted suction dredging near the outlet works or other areas from which sediment may be mobilized;
- Modify CVD infrastructure (e.g., the dam itself, outlet works, etc.) to allow variable water release locations, depending on conditions;
- Divert a portion of the CVD outflow into a biofilter; and
- Reduce sediment input to Lake Mendocino from upstream sources.

These sorts of complex solutions would require authorization and funding separate from the current flood control and water supply project. Additionally, there is substantial uncertainty about their potential effectiveness and which, if any, could or should be implemented. The USACE intends to pursue funding under section 216 of the Flood Control Act of 1970 (P.L. 91-611) for a reconnaissance level study of this issue to begin within three years of the date of the biological opinion. The TAC will provide input and review the results of this study, and USACE will determine a path forward potentially leading to implementation of one or more solutions if appropriate, pending authorization and funding.

3.3 Estuary Management

3.3.1 Adaptive Beach Management

The *2008 Biological Opinion* tasked Sonoma Water with modifying its estuary management activities by creating an outlet channel intended to enhance juvenile steelhead rearing habitat in the Estuary while minimizing flood risk to low-lying properties adjacent to the Estuary. The plan targeted a lagoon management season from May 15 to October 15, with the intent of optimizing habitat for juvenile steelhead in the Estuary during important months of the year for juvenile rearing. The outlet channel concept was intended to meet two primary objectives: (1) minimize flood risk to low lying properties adjacent to the Estuary, and (2) enhance juvenile steelhead rearing habitat.

After initial adoption of the Adaptive Management Program (AMP), beach management closely followed guidance of the RPA and the approved AMPs for each year. These plans were developed each year after reviewing prior monitoring data in the Estuary and considering lessons learned. Each updated annual AMP was developed in consultation with staff from NMFS, CDFW, California State Parks (CSP), NCRWQCB, and the California Coastal Commission (Coastal Commission). Initially, the planning process focused on implementation of an outlet channel during the lagoon management season. Ultimately the outlet channel approach to closures during the lagoon management season was not successfully implemented, due to a number of limitations that are inherent to the dynamic beach setting and were outside the control of Sonoma Water. These conditions and challenges are described in more detail in Section 4, *Environmental Baseline*. Despite these challenges, baseline monitoring and annual AMP development continued, along with continued study by Sonoma Water, NMFS, University of

California, Davis (UC Davis), and others regarding juvenile steelhead rearing habitat requirements and use of the Estuary as part of the NOAA's Habitat Blueprint Russian River Focus Area (RRHFA) program.

Beginning in 2018, staff from Sonoma Water, NMFS, CDFW, NCRWCB, USACE, Coastal Commission, and consultants, began reviewing the 10 plus years of baseline monitoring data collected in the Estuary to incorporate the updated understanding of estuarine and beach morphology biological and physical processes into the AMP conceptual model. This review included capturing the multiple considerations of biological, water quality, and physical data that must be considered when planning beach management activities following natural closures, including enhancing juvenile steelhead habitat. This also included considering the lagoon water surface elevation that could be managed for closures to persist after water levels reached 7 feet National Geodetic Vertical Datum of 1929 (NGVD29) but before the upper threshold of 9 feet NGVD29 to minimize flood risk. This change was documented in the 2019 AMP with a new decision tree approach for beach management during the lagoon management season (see Section 4.3.7, *Russian River Estuary*). The decision tree incorporated additional monitoring data into the decision-making process, so that decisions about beach management are based on recent habitat conditions for salmonids in the lagoon.

Under the Proposed Action, Sonoma Water would continue to perform adaptive beach management following natural closures throughout the year, focusing on maximizing salmonid habitat while minimizing flood risk to low-lying properties adjacent to the Estuary. However, the Proposed Action would not call for implementation of an outlet channel as described in the *2008 Biological Opinion* RPA. When natural inlet closure events occur, a similar decision-tree approach would be followed, but the primary decision points would be related to the choice of target water surface elevation in the lagoon and timing for breaching the inlet, to maximize habitat for salmonids in the Estuary based on the most recent monitoring results of water quality in the Estuary, and the timing of the event with respect to the pertinent life-stages and species use within the Estuary. Life histories for salmonids in the Estuary are described in Section 5, *Status of Species and Critical Habitat*, and summarized here for the purposes of describing the procedures of the Proposed Action in the Estuary.

3.3.1.1 Management Considerations

Specific considerations for managing the beach vary throughout the year and are summarized below and in **Figure 3-3a**. Additionally, Sonoma Water will consult with the resource agencies on beach management activities.

- **Chinook Salmon, Coho Salmon, and Steelhead Smolt Emigration:**
    - **Continue to maintain water levels below flood risk threshold during closed-inlet conditions for all months of the year**: Manage lagoon water surface elevation to minimize flood risk by preventing water surface elevations from exceeding 9 feet NGVD29; the stage at which beach management is scheduled depends on considerations of potential for flood risk, safety, lagoon habitat conditions, Chinook Salmon, Coho Salmon, and steelhead smolt emigration timing, and logistics.

- **Juvenile Steelhead Rearing**:
    - **Manage for habitat conditions that benefit habitat conditions for juvenile steelhead acclimating to salinity in spring months:** Limit management actions during the spring months (specifically the months of March through June) when young-of-year (YOY) steelhead typically begin arriving in the Estuary from upstream. Allowing inlet closure events with lagoon water surface elevations approaching the 9-foot NGVD29 stage at this time allows juveniles to acclimate to higher salinities and increase in size before reaching the ocean. Beach management during this season is also complicated by the presence of harbor seal pups on the beach in the vicinity of the inlet. A challenge with allowing for inlet closure to persist to elevations approaching the 9-foot NGVD29 stage in the early spring months is that watershed conditions may still be wetter and river flows tend to be higher and rainfall events still often occur. If forecasted river discharge conditions are expected to be high, the inlet should still be managed to minimize flood risk.
    - **Enhance habitat conditions for rearing in summer:** Manage the Estuary to promote estuarine habitat conditions that are favorable during important rearing months (May through October). Baseline data in the Estuary demonstrates that juvenile steelhead growth and acclimation to salinity increases through the rearing season, with larger and older juveniles growing in open estuary conditions[18] Depending on the timing of closure and the juvenile steelhead's tolerance to salinity, (to be informed by the water quality monitoring results in the Estuary, this may involve allowing the inlet to remain closed for as long as possible before reaching flood risk stage (if conditions are favorable in the Estuary to benefit freshwater-acclimated juveniles) or breaching the barrier beach sooner to improve habitat conditions (to benefit marine-acclimated juveniles).[19]
- **Chinook Salmon, Coho Salmon and Steelhead Adult Immigration (Estuary Entry)**:
    - **Manage for adult migration conditions in fall and winter:** From October through March, monitor river temperatures and discharge at Hacienda Bridge. If river water temperatures or instream flow conditions are unfavorable for adult immigration, it may be favorable to allow the inlet to remain closed until water levels reach 9 feet NGVD29. If conditions are more favorable for upstream migration, consider breaching the barrier beach before water surface elevation approaches 9 feet NGVD29, to maximize the time available for immigration. Sonoma Water will coordinate with NMFS and CDFW staff on breach timing during this period with respect to breaching if water quality conditions in the river are determined to be detrimental to salmonids.

The decision tree shown in **Figures 3-3a** through **3-3d** is intended to incorporate both seasonal and recent data collected by Sonoma Water and publicly available data collected by other agencies. This decision tree is based on the decision tree documented in the 2019 AMP as described in Section 3.3.1, *Adaptive Beach Management* above. Some of this data, such as Estuary water levels, are collected continuously and are available in real-time via telemetry. Because these data are readily available, they are often considered real-time throughout the decision-making process. Other data, such as fish monitoring, are only available after post-

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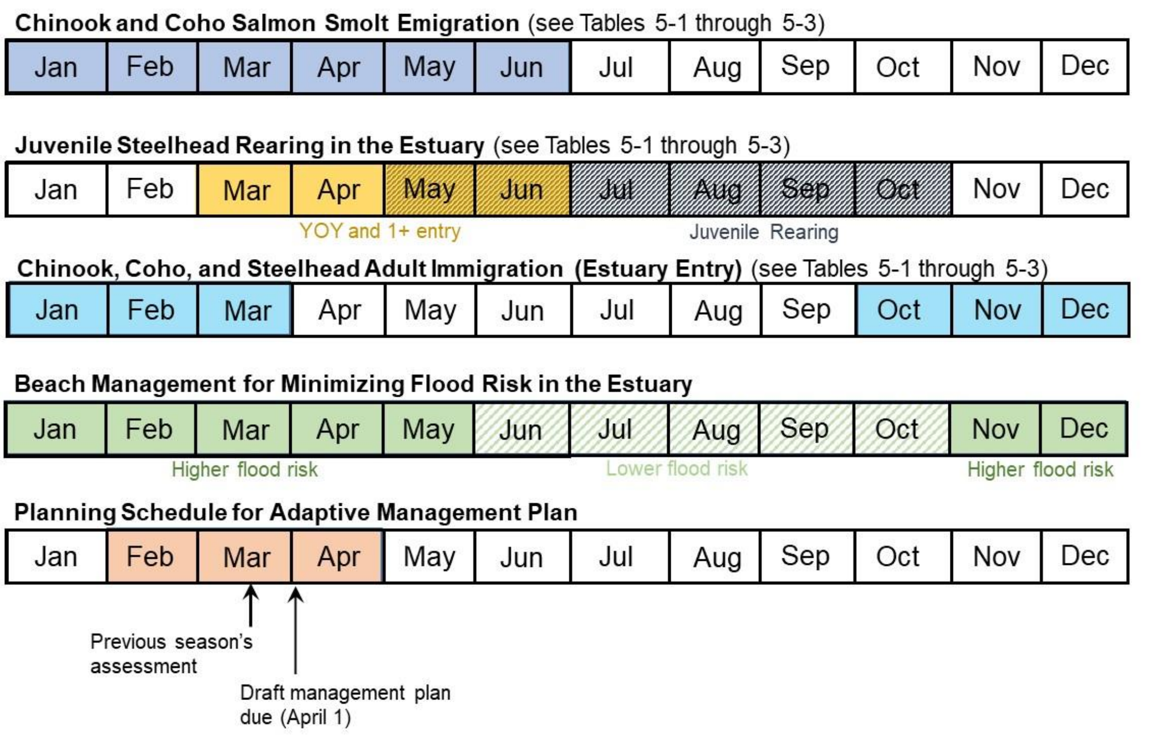
[18] Matsubu, W.C. 2019, Tradeoffs of juvenile steelhead (*Oncorhynchus mykiss*) rearing in an intermittently closed estuary, northern California USA. PhD Thesis, University of Washington.

[19] Boughton et al. (2017) includes a discussion of water quality paramters used to inform habitat availability and productivity components for juvenile salmonids in the estuary including temperature, dissolved oxygen (DO), and salinity.

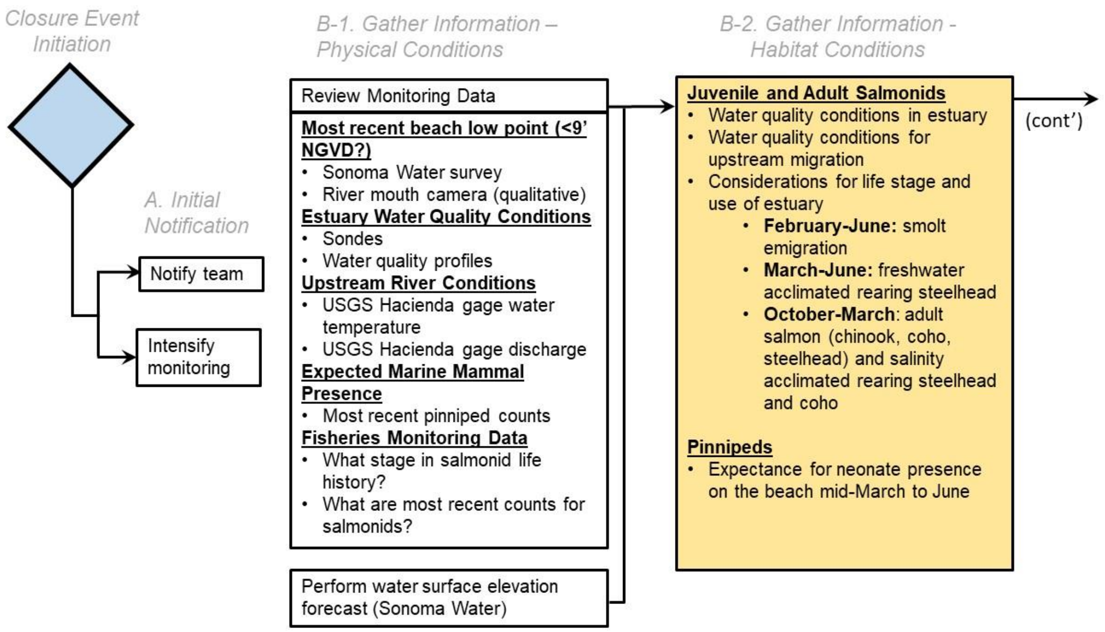
processing and compilation, so are available less frequently, and used for the adaptive management of the decision-making process (e.g., annual updates to the beach management plan).

Water quality conditions are proposed to continue to be monitored in the Estuary by Sonoma Water utilizing seasonal (May to October), continuously recording datasondes at a series of fixed vertical-profile stations (see Figure 4-13 in Section 4.3.7.8, *Water Quality Monitoring*). Additionally, boat-based vertical profiles of water quality parameters will continue to be collected during inlet closure events. These data are typically collected on an opportunistic basis, when staff are available, and are used to populate a database of habitat conditions in the Estuary which can be displayed via the Habitat Viewer tool developed under the RRHFA. When available, water quality data in the Estuary will be used to create a snapshot of habitat conditions during closure events, which can then inform decisions about the timing of beach management activities (See step D3 in Figure 3-3c).



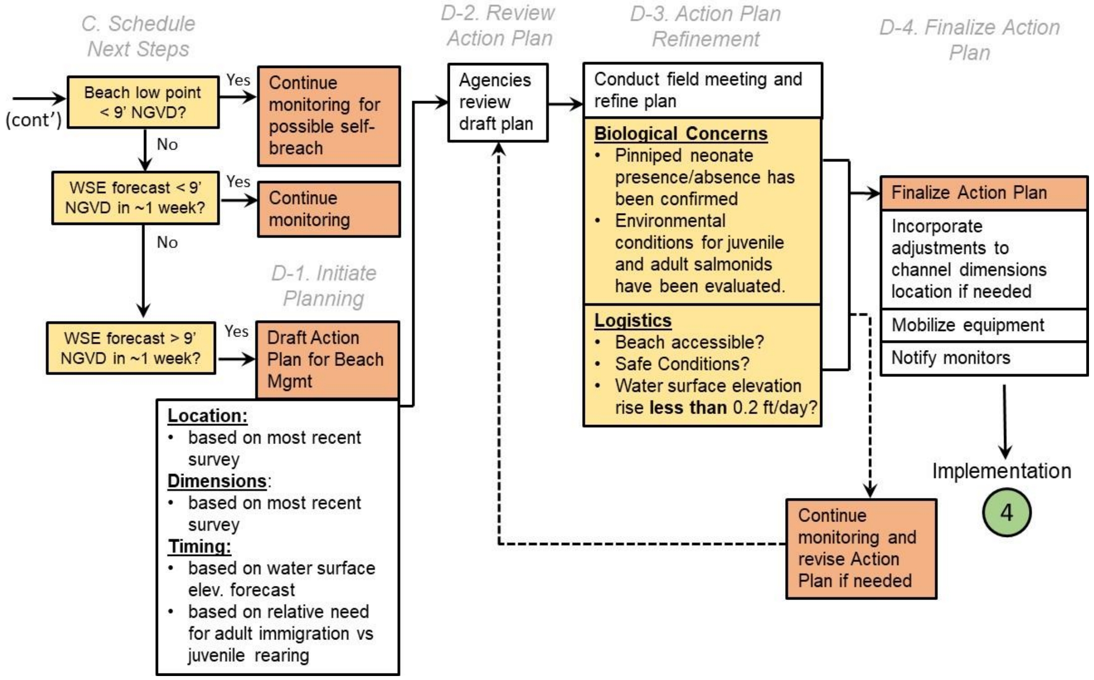
SOURCE: ESA

Figure 3-3a
Considerations for beach management



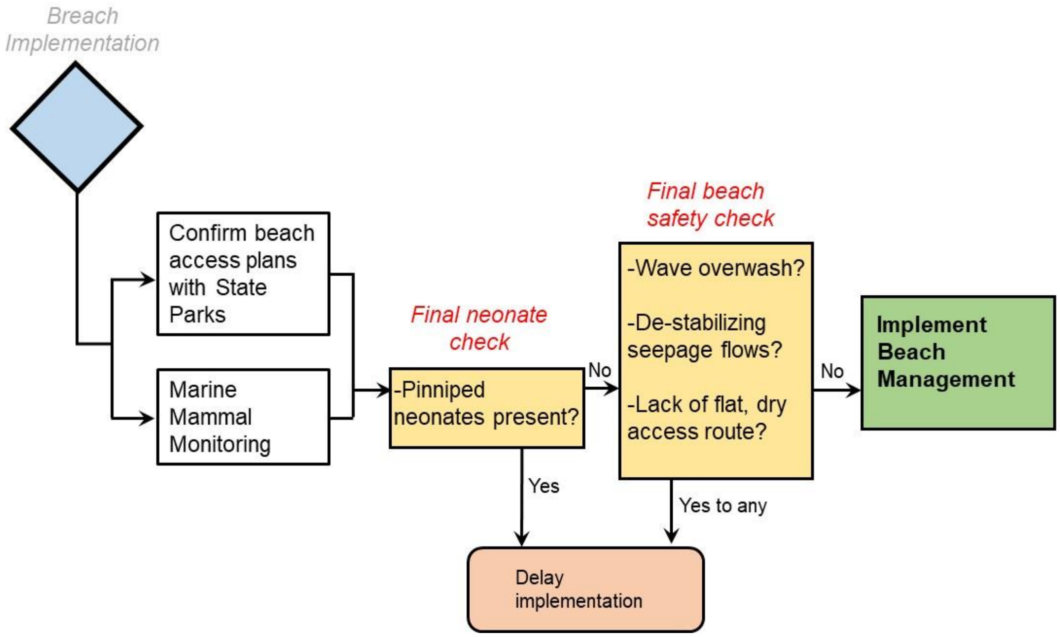
SOURCE: ESA

Figure 3-3b
Adaptive Beach management: Closure event monitoring and planning



SOURCE: ESA

Figure 3-3c
Adaptive Beach management: Closure event monitoring and planning (cont'd)



SOURCE: ESA

Figure 3-3d
Adaptive Beach management: Implementation Phase

3.3.1.2 Beach Management Procedure

Once a closure occurs, the decision-making steps for beach management to facilitate lagoon conditions are as follows and shown on Figure 3-3b through Figure 3-3d:

A. **Initial Notification** – Sonoma Water notifies the staff from agencies involved with the AMP process (NMFS, CDFW, CSP, NCRWQCB) by email about the closure and about relevant hydrologic and geomorphic conditions.

B. **Gather Information and Forecasting** – Sonoma Water intensifies hydrologic and geomorphic monitoring by more frequent collection of ocean wave, tide, and riverine discharge data and forecasts, forecasting the rate of the lagoon water surface elevation rise, and, to the extent feasible (given staff availability, safe beach access, and marine mammal presence), surveying minimum beach crest elevations north of the jetty groin. This phase also includes review of available water quality information in the Estuary, available from recent monitoring. This is used to infer habitat suitability in the Estuary.

C. **Schedule Next Steps** – Based on the elevation of the beach crest’s low point and the water surface elevation forecast, Sonoma Water either continues monitoring (i.e., iterate back to Step B) or proceeds to preparing a plan for beach management action.

D. **Plan Beach Management Action** – In collaboration with resource agency staff, Sonoma Water prepares a draft plan for a beach management action. Details regarding the selection of the action’s type, timing, location, and dimensions are described in more detail in the AMP. In addition, Sonoma Water strives to include agency staff in iterative plan review and refinement, ideally by hosting a field meeting overlooking the beach about one week before implementation, as schedules, available information, and Estuary conditions allow.

Section 9 of the Russian River Estuary Adaptive Beach Management Plan 2023 (ESA, 2023) provides an example of the timing of notifications regarding beach management decisions. Depending on the timing of closure and river flows, ocean conditions, tides, and weather conditions, decisions may need to be made within 24 hours or up to several weeks. After the plan for beach management activity is finalized, Sonoma Water begins the logistical process for implementation. In the days just before implementation, Sonoma Water confirms beach access plans and conducts marine mammal monitoring, with particular attention to see if seal pups less than one week old (neonates) are present and preclude beach access (typically mid-March to June). Also, State Parks staff and local emergency services staff are notified. Safe beach access is closely monitored up to and during personnel and equipment presence on the beach. Conditions such as wave overwash, de-stabilizing seepage flows, or lack of a sufficiently flat and dry access route can make beach access unsafe. To the extent that other schedule constraints allow, beach management to breach the barrier beach is implemented during a falling tide, to increase the potential for scour and breaching.

3.3.2 Estuarine Flood Risk Management

Under the Proposed Action, Sonoma Water would continue to manage the barrier beach to minimize flood risk to low-lying properties in the Estuary throughout the year and would evaluate potential flood risks in the Estuary resulting from future climate change. Minimizing flood risk while also managing the beach to achieve water levels below the flood threshold of 9 feet NGVD29 will require following a process for anticipating and managing for flood stages, similar to the decision-tree approach outlined above. Sonoma Water will continue to implement beach management events when water levels are forecasted to exceed 9 feet NGVD29 and threaten flooding of low-lying properties.

The decision-making process outlined above will be followed, with beach management initiated when water levels are forecasted to exceed 9 feet NGVD29 at the Jenner visitor center gage. Otherwise, water surface elevations will be allowed to continue below 9 feet NGVD29 if they are expected to persist, and if desired salmonid habitat conditions are being achieved. The beach will be managed to minimize flood risk to low-lying properties. This will rely on forecasting of lagoon water surface elevations. Note that peak flood stages may occur as a result of high beach elevations coinciding with minor or intermediate river discharge (non-breaching flows), as occurred in December 2015.

Flood risk management activities should be reviewed for consistency with the Local Coastal Plans adopted for Sonoma County by the Coastal Commission, as they become available.[20] This will include considerations of sea-level rise and its potential effect on coastal water levels near the Estuary. Though the biological opinion is unable to propose measures that obligate management actions specifically to address climate change, sea-level rise is likely to influence estuarine conditions, habitat and water quality conditions, and flood risk.

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[20] The revised Local Coast Plan was approved by the Sonoma County Board of Supervisors on July 17, 2023. The California Coastal Commission will need to certify the updated Local Coastal Plan before it goes into effect.

3.3.3 Habitat Enhancement Measures in the Estuary

Proposed beach management activities discussed in Section 3.4.1 would occur during important months for steelhead rearing in the Estuary. Under the Proposed Action, Sonoma Water would offset the effects of flood risk minimization activities that occur during the steelhead rearing season by implementing habitat enhancement measures in the Estuary. Sonoma Water will direct the development of conceptual feasibility studies for habitat enhancement opportunities, as well as preparation of CEQA documents and relevant permits. Sonoma Water will direct this process to implement measures in the short term, while planning for long-term project work that is still developing.

3.3.3.1 Potential Measures and Habitat Enhancement Locations

Sonoma Water will oversee the development and prioritization of a list of habitat enhancement projects, intended to improve rearing habitat for juvenile steelhead in the Estuary. Criteria will include:

- Ground surface elevation relative to water level regimes,
- Hydrologic connectivity of enhancement measures,
- Influence of measures on water quality,
- Site size,
- Current land use,
- Influence on flood hazards,
- Presence or absence of existing endangered species
- Cost

The size of each site is expected to be scalable (within feasible bounds based on local geography, land ownership, existing habitats, and other constraints). It is expected that one or more sites could ultimately be scaled to meet a desired habitat benefit that provides an offset needed from other activities comprising the Proposed Action. For any one site, one or more measures could be combined to optimize the habitat enhancement opportunities at that specific location. Before implementing any of these enhancements, additional work regarding feasibility, design, environmental compliance, and funding will be needed. Potential measures may include several types of improvements:

- **Grading areas adjacent to the Estuary:** Re-grade the ground surface, by placing or excavating soil, to modify the ground surface elevation relative to water levels. Since transporting soil to or from a site is expensive, sites which are already close to target elevations or which the net import/export of soil can be avoided, are preferable.

- **Improve hydrologic connectivity:** At some sites, the ground surface of some or all of the site may already be at appropriate elevations. However, hydrologic connectivity to these elevations may be impeded by hydraulic structures or earthen berms, or limited to inundation only during overbank flow. At these sites, modifying or removing the barriers to inundation, or excavating connecting channels, can provide better inundation conditions and fish access. Based on existing channels in the Estuary, new channels would likely have thalwegs in the intertidal range to encourage fish access during high tide and closed conditions. However, new channels should be configured so as to not facilitate flow capture during high riverine discharge that could encourage channel or floodplain scour.

- **Vegetation management**: May be implemented to improve the extent and diversity of estuarine marsh and riparian upland plants. In addition to modifying the hydrology with the prior two measures, this measure may entail removing non-native species and planting target species. Target species are natives that secure soil in place, support the base of the food chain, and provide shade to adjacent waterways.

- **In-water habitat structures:** Can be provided with the addition of large woody debris (LWD), in the form of unhewn logs placed in inundated areas, with sufficient anchoring that they are unlikely to move during large flow events. LWD creates regions of flow and habitat diversity, which can increase shelter and prey availability for juvenile salmonids.

This list is based on a review of recent and current restoration and long-term management efforts in similar estuaries in California and Oregon. It includes several major categories of enhancements, but may include other complementary measures as continued adaptive management of the Estuary and continued monitoring data collection provide more understanding of the system. Other measures that may provide a habitat benefit could include management of the riparian zone (to provide additional shade and reduce water temperatures) and management of submerged aquatic vegetation, such as eelgrass (*Zostera marina*). A small amount of eelgrass has been mapped in the lower Estuary near Penny Island. However, it has not been observed upstream, and high temperatures in the middle and upper Estuary are known stressors than have limited eelgrass restoration efforts elsewhere. Eelgrass management is also beyond the scope of this effort, which is focused on offsetting impacts to salmonids.

Projects will be identified through a series of feasibility studies that will leverage prior monitoring data collected in the Estuary, and tools and studies developed for the Estuary as part of the RRHFA (described in more detail in Section 4, *Environmental Baseline*). These include the recent study by Boughton et al. (2017) and the Estuary Habitat Viewer tool developed by UC Davis that identifies and quantifies juvenile steelhead rearing habitat zones in the Estuary based on water quality conditions. Feasible projects will be carried through design and permitting with oversight from Sonoma Water and regulatory agencies. Project feasibility will include short-term improvements to salmonid habitat in the Estuary, and long-term resilience in the face of sea-level rise and its expected changes to conditions in the Estuary. Sea-level rise assessments will include consideration of short-term (life of the Biological Opinion) and long-term (mid- or late-century) horizons.

A number of initial sites have been identified as potential areas for habitat enhancement as part of the RRHFA. This list will be refined in the future and a screening process and opportunities and constraints assessment would be implemented to identify a subset of priority sites for continued design and construction. In general, locations identified as critical habitat needing rehabilitation for threatened CCC steelhead rearing habitat, and to a lesser degree CCC Coho salmon, will be prioritized. Penny Island, Goat Hill Floodplain, and Patty’s Rock Floodplain are located within Marinthe Russian River State Marine Recreational Management Area (SMRMA) Marine

Protected Area (MPA).[21] As such, planning for enhancement measures within these sites) would be conducted in coordination with CDFW. At this time, initial sites include:

- **Penny Island:** An existing large island within the lower kilometer of the Estuary consisting of 48 acres of vegetated floodplain. Much of the island (including all of the western end) are intertidal, and historical mapping from almost a century ago shows two small tidal marsh regions on the island, with the remainder of the island vegetated with upland grassland. The site is owned by State Parks and the State Lands Commission. The site offers potential for enhancing intertidal and supratidal habitats in a portion of the Estuary that tends to have cooler temperatures and more saline conditions than upstream. It currently has hydrologic connectivity along its entire border, but primarily in the form of overbank flow since only a few short tidal channels currently penetrate into the island. Tidal channels could be added to the site as an enhancement measures, to further increase connectivity. Such channels would enable connectivity through more of the tidal cycle and create additional habitat complexity.
- **Goat Hill Floodplain:** Floodplain area on southern edge of the lower Estuary, immediately adjacent to Penny Island. The site experiences tidal fluctuations from the southern distributary channel of the Estuary passing along the south side of Penny Island. The majority of the western portion is within intertidal elevations. The eastern portion has higher ground surface elevations that are in the supratidal range and slope upwards towards flood tide elevations. A map from 1930 indicates that the western portion was tidal marsh and the eastern portion was grass uplands. Both portions are currently vegetated with a mix of wetland and upland species. The majority of the site is publicly owned, as part of Sonoma Coast State Beach. The site was identified as a potential area for enhancing off-channel habitats at intertidal and supratidal elevation ranges, and for providing sea-level rise transgression space.
- **Patty's Rock Floodplain:** This site, also known as the 'Horseshoe Bend' is a 140-acre area within the northern floodplain of the Estuary near the Highway One crossing. The site's elevations range from subtidal to uplands for current conditions, with higher elevations on the eastern portion of the site. The interior of the site contains a seasonal freshwater wetland. It is currently privately owned and used for cattle grazing, and may not become available for future enhancements. Because a substantial portion of the site's area is at higher site elevations, the site has ample capacity for upward transgression of wetlands habitat in response to sea-level rise, and could provide valuable floodplain habitat for salmonids, which could be enhanced with intertidal and supratidal channels to enhance hydrologic connectivity.
- **Willow Creek Marsh and Lower Channel:** The floodplain along lower Willow Creek forms 70 acres of habitat at the confluence of the creek with the main stem of the river. The site is owned by State Parks (as part of Sonoma Coast State Beach), and its watershed has been the focus of several small restoration efforts. Towards the creek mouth, the ground surface elevations are somewhat evenly distributed between intertidal, supratidal, and flood stage water levels. Upstream, about forty percent of the site falls within the uplands water level regime. The gentle upstream slope along the creek's floodplain provides opportunities for smooth transgression of habitat with sea-level rise. With three feet of sea-level rise, about half the site would be in the intertidal and supratidal water level regimes, and almost 40% of the site would still be at higher flood stage and uplands regimes to provide an ecotone and enable transgression for even greater sea-level rise. The creek's watershed is minimally developed, but past logging and grazing has caused erosion and excess sedimentation in the creek. The creek's perennial flow tempers the salinity of the site when water levels are in the

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[21] Only the portion of Patt's Rock floodplain downstream (west) of Highway 1 is located within the MPA.

intertidal range, and can provide refugia for juvenile salmonids that are not marine-acclimated, as well as for juvenile Coho Salmon. During closed lagoon conditions, saline water can more readily back up into the marsh. The lower creek's vegetated floodplain creates robust marsh habitat when inundated and the vegetation also provides some shading to help reduce water temperature. Habitat enhancements could include excavating channels to increase the aquatic habitat for juvenile salmonids, as well as to improve hydraulic connectivity to the floodplain. The exact layout of channels will be based on a review of historical images of the site and study of reference marsh channel densities elsewhere (both in the Russian River Estuary and within similar estuaries in California and Oregon). Coastal marsh channel networks tend to follow patterns of behavior (e.g. channel lengths and densities relative to marsh area) that vary from site to site in estuaries and embayments.

- **Upper Estuary Mainstem:** The steep-sided channel geometry of the upper Estuary limits the availability of floodplain habitat. However, this reach is an important constraint on seasonal outmigration of salmonids, which are generally exposed to the river's seasonally warmer temperatures and a less saline water quality environment than the lower or middle reaches. Without the adjoining floodplain areas found in the lower and middle Estuary, habitat enhancement opportunities are limited in the upper Estuary to the installation of large woody material (LWM) or similar habitat structures in the main stem's channel. LWM creates regions of flow and habitat diversity, which can increase shelter and prey availability for juvenile salmonids. Placement should also consider local bathymetry, to encourage beneficial interaction between the LWM and pre-existing flow features generated by local bathymetry variations, such as gravel bars and channel bends.

The exact timeline for implementation of enhancement is difficult to determine given constraints outside Sonoma Water control including uncertainties related to environmental review and permitting, land acquisition, and public involvement/approval. The expected timeline for conducting a feasibility study is approximately two years from issuance of the biological opinion. The study would identify the highest priority and/or most feasible site(s) for habitat enhancement, identify and hone the preferred enhancement measures, and provide concept-level designs. These could then be carried further through final design, environmental compliance, and construction during subsequent phases.

3.4 Channel Maintenance

The Proposed Action includes limited maintenance activities associated with the channel improvements implemented by the USACE following completion of CVD and WSD on the mainstem Russian River below CVD and in Dry Creek below WSD. Future channel maintenance for facilities outlined in the O&M Manual for the Russian River Channel Improvement Project as undertaken by Sonoma Water are not included as part of the Proposed Action. Previously covered maintenance activities either were completed under the lifespan of the *2008 Biological Opinion*, are being taken over by other public entities (e.g., City of Cloverdale), or are no longer necessary to maintain the functionality of the remaining channel improvement sites. Therefore, future Sonoma Water channel maintenance actions would be limited to Dry Creek. The Mendocino County Russian River Flood Control & Water Conservation and Improvement District (MCRRFC&WCID) would continue to conduct channel maintenance activities on the mainstem Russian River.

3.4.1 Russian River Channel Maintenance

The MCRRFC&WCID will continue to perform stream bank maintenance consisting of obstacle removal,[22] stream bank repair, and preventive maintenance over a 58-km reach of the Russian River in Mendocino County from the county line north of Cloverdale upstream along the river north to the town of Calpella. The MCRRFC&WCID also is responsible for any channel maintenance actions in the East Branch Russian below CVD downstream to the confluence with the Russian River, a 1.6 km reach. Maintenance actions include sediment removal and debris clearing, vegetation management, and streambank stabilization. Methods used to conduct this work would be consistent with those outlined below under Section 3.4.2, *Dry Creek Channel Maintenance*.

3.4.2 Dry Creek Channel Maintenance

Channel improvements at 15 sites along Dry Creek were built by USACE between 1981 and 1989 as part of the WSD and Lake Sonoma Project. The improvements include three rock-type grade-control structures, 5,800 feet of riprap bank protection, and flow-deflection fences. These improvements were intended to provide bank and riverbed stabilization at sites where erosion previously occurred or where studies indicated that future erosion was likely due to the construction and operation of WSD. Maintenance responsibility for the channel stabilization project lies with Sonoma Water as the local sponsor, as established by an agreement between Sonoma Water and USACE in June 1988. USACE provided Sonoma Water with the *Warm Springs Dam and Lake Sonoma Project, Russian River Basin, Dry Creek Channel Improvements, Sonoma County, California Operation and Maintenance Manual*.[23] This manual provides information, instruction, and guidance to the personnel responsible for proper operation, inspection, and maintenance of channel improvements and bank stabilization measures along Dry Creek downstream of WSD. This includes maintenance work associated with these sites involving incidental sediment removal, vegetation management, debris removal, and bank stabilization to ensure the structural integrity of the improvements. In 2018, one of the rock-type grade-control structures was removed by the USACE as part of the Dry Creek habitat enhancement efforts associated with the *2008 Biological Opinion*. Outside of the work done on the remaining 14 channel improvement sites in Dry Creek, additional vegetation removal for flood control or bank erosion has not been performed in Dry Creek by Sonoma Water or USACE since the issuance of the *2008 Biological Opinion*.[24]

Under the Proposed Action, Sonoma Water would continue to conduct channel maintenance activities at the Dry Creek facilities included in its O&M Manual. Maintenance activities will be conducted on an as-needed basis. Sonoma Water’s general approach in conducting routine maintenance activities is to first avoid and/or minimize potential impacts wherever possible. Potential impacts can also be minimized through site-specific decisions on how to conduct maintenance at facilities, as well as more comprehensive protocols on how to minimize potential

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[22] Any in-channel obstacle which causes the stream to be directed into the riverbank. Typically, the obstacles removed would be old jacks.

[23] USACE, 1991. Warm Springs and Lake Sonoma Project Russian River Basin, Dry Creek Channel Improvements Sonoma County, California: Operation and Maintenance Manual. Sacramento District. July.

[24] A concrete sill was removed as part of the USACE Continuing Authorities Program (CAP) 1135 project in 2018.

impacts, such as implementation of BMPs (see *Channel Maintenance Best Management Practices*).

Sonoma Water channel maintenance activities on Dry Creek are mostly limited to maintaining USACE channel flood control improvements to prevent streambank erosion following construction of WSD. These sites include rock streambanks, board fences, concrete weirs, concrete sills and one rock sill and streambank (**Table 3-6**). A concrete sill (#12) was removed as part of the USACE Continuing Authorities Program (CAP) 1135 project in 2018.

TABLE 3-6
CHANNEL IMPROVEMENT SITES ON DRY CREEK

Site	Type	Length (feet)
1	Rock Bank	600
2	Rock Bank	750
3	Board Fence	700
4	Rock Bank	200
5	Concrete Weir	-
6	Rock Bank	450
7	Board Fence	900
8	Rock Bank	480
9	Concrete Weir	-
10	½ Rock Sill and Bank	-
11	Rock Bank	200
12	*Concrete Sill (removed)*	-
13	Concrete Sill	-
14	Concrete Sill	-
15	Rock Bank	500

SOURCE: NMFS, 2008. Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River Watershed.

Under the Proposed Action, Sonoma Water will continue to maintain the remaining 14 channel flood control improvement sites. Maintenance work associated with these sites will involve incidental sediment removal, vegetation removal, removal of debris, and streambank stabilization. Vegetation removal will only occur to improve streambank stability if trees are leaning or otherwise directing high flows against the streambank, causing erosion, and/or to visually inspect a streambank stabilization structure. Streambank stabilization work typically involves replacing lost riprap and, if necessary, re-grading the streambank slope to its previous contours to provide a stable base for the riprap. In the unlikely event that dewatering and relocation is required to support riprap placement below the waterline Sonoma Water will implement the protective measures outlined below in Section 3.4.3.8, *Salmonid Relocation Measures*.

Outside of the work done on the 14 grade and streambank erosion control structures, additional vegetation removal for flood control or streambank erosion is not a USACE obligation and would not be performed in Dry Creek. However, limited work may be performed in Dry Creek, specifically at landowner request in response to extreme flood flows that result in streambank erosion that threatens property or structures. This type of work would occur infrequently.

3.4.2.1 Maintenance Actions

Sediment Removal and Debris Clearing

Sediment buildup can reduce the capacity of channels and reduce the level of flood protection. Sediment removal activities are more common within constructed flood control channels but may be occasionally necessary within natural waterways to maintain channel capacity and control streambank erosion. Sonoma Water would not perform routine sediment removal activities in natural waterways, rather, emergency sediment and debris removal would only be conducted in natural waterways if required to restore hydraulic capacity or prevent severe streambank erosion.

If vegetation removal is required, two- to four-person crews would clear brush by hand with chainsaws and loppers. In heavy brush, a chipper would be used to break up the slash so that it can be disposed of, rather than leaving it to decay in the stream. Larger material would be cut into shorter lengths and removed from the site. Woody material would be cut up and pulled out by a truck with a winch. Trees and limbs would be removed from the stream channel only if required for flood protection. While planting native vegetation would not be a standard practice during channel maintenance activities, occasionally native tree planting projects by volunteer groups would be coordinated or permitted by Sonoma Water.

Vegetation Management

Vegetation management activities are conducted to maintain flow conveyance capacity, establish a canopy of riparian trees, control invasive vegetation, remove hazardous vegetation, reduce fire fuel, and increase visibility for public safety. Mechanical removal is the primary method for managing problematic vegetation. Herbicides are used only outside of water and minimized to the smallest amount necessary to be effective and only applied above the ordinary high-water mark. Vegetation management and removal activities are relatively consistent from year to year, though locations change depending on recent growth and blockages.

Maintenance on natural waterways would consist of clearing vegetation from the bottom of natural waterways to restore hydraulic capacity. Hand labor using hand tools is the typical clearing method. Heavy equipment would only be used to lift out or clear debris jams not accessible to or too large for hand crews. In areas with mature riparian canopies, some vegetation understory along the channel streambanks and in the main channel that could substantially reduce hydraulic capacity would be removed by mowing (upper third) or hand clearing, as needed. This practice would be implemented by Sonoma Water staff, including both operations and maintenance personnel and staff biologists. Sonoma Water staff may occasionally need to use herbicides (approved for aquatic use) and/or hand labor to remove invasive exotic species.

Native riparian vegetation would not be removed unless it presents a significant flood risk. Sonoma Water staff have observed, through various maintenance and riparian enhancement projects, the effectiveness of maintaining (thinning or pruning) or planting native trees along the streambank in a line parallel to the stream.[25] These trees and plantings have increased the riparian habitat value of the stream.

Sonoma Water tries to maintain and not remove vegetation that provides channel stability, anchors in-channel bars, or provides habitat benefits through the presence of LWM. Key determinants for retention include whether the LWM is deflecting flow toward streambanks and the proximity to a channel crossing or other facility. While the habitat benefits of LWM are sought, these benefits are evaluated in balance with potential flooding or erosion effects, or threats to infrastructure downstream due to the presence of LWM.

Streambank Stabilization

The repair and stabilization of streambanks is only undertaken when a streambank is weakened, unstable, or failing. Negative consequences of failing streambanks include:

- Causing damage to adjacent properties;
- Increasing the flood hazard and threat to public safety;
- Impairing roads, transportation, and access;
- Increasing channel incision and losing complexity;
- Generating erosion and increasing downstream sediment yields; and
- Impacting riparian habitat and other natural resources.

Historically, Sonoma Water has worked with local landowners to implement bioengineering projects to assist with streambank erosion problems. This change in streambank stabilization procedures has assisted landowners in protecting the streambank and has improved riparian and fish habitat along the Russian River and its tributaries. Occasionally, streambank stabilization and sediment removal would be performed on natural waterways, including the Russian River, in response to streambank erosion after unusually large storm events at the request of the landowner and in coordination with state and federal agencies when applicable.

Potential activities would include streambank stabilization, levee repair, vegetation or sediment removal, or channel realignment. These activities would be initiated only by a request from a private landowner after a washout threatens property or structures and would only be initiated in coordination with CDFW. Based on history, such activities occur approximately once every 5 to 10 years. Typical project lengths under these circumstances are approximately 500 feet but could be up to 1,000 feet. Sonoma Water would not implement streambank stabilization or sediment removal activities in natural channels if more than 1,000 feet of channel would be affected by any single project. A separate FESA Section 7 Consultation would be initiated for actions that affect more than 1,000 feet of channel, occur more than once every 5 years, or would be within 1,000 feet of a previously armored site.

Bioengineered streambank stabilization methods would be given priority on smaller channels (less than 50 feet wide), when they are deemed to be a feasible and effective treatment. In larger channels where bioengineering techniques would not be feasible or effective, riprap or other hard-

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[25] SCWA, 2021. *Op. cit.*

armoring measures may be used, although this is less common. Vegetative plantings would be incorporated into these streambank stabilization measures as feasible. Fish habitat enhancement elements would be incorporated into streambank stabilization measures where feasible. Examples of such measures include the use of native material revetments, which combine boulders, logs, and live plant material to armor a streambank. Revegetation with native plant species would always be implemented in association with streambank stabilization measures if site conditions are suitable.

As part of streambank stabilization efforts, it may also be necessary to remove deposited sediments or vegetation growing on gravel bars. Preference would be given to thinning vegetation on gravel bars, which allows gravel to move over time so that it does not have to be excavated with heavy equipment. While targeted gravel bar removal is not proposed, it may be necessary to remove small amounts of gravel that have deposited within constructed habitat features as-needed to maintain flow and function of those features (see Section 4.4.4, *Dry Creek Habitat Enhancement*). If large woody material is present in the excavated sediment deposits, it would be removed from the stream only if it threatens to de-stabilize a section of streambank. Otherwise, the large woody material would be allowed to remain in the channel. On occasion, it is preferable to straighten a short portion of the channel by cutting off a meander instead of excavating the bar sediments if the streambank cannot be sufficiently stabilized by other means. If this realignment practice is used, Sonoma Water will consider mitigating for lost habitat by incorporating native material revetments.

3.4.3 Channel Maintenance Best Management Practices

3.4.3.1 Work Window

- All ground-disturbing maintenance activities occurring in the channel (i.e., from top-of-bank to top-of-bank) will take place during the low-flow period, between June 15 and October 31. Exceptions may be made for emergencies or on a project-by-project basis with advance approval from NCRWQCB, CDFW, NMFS, and/or USFWS as appropriate.
- Prior to significant rainfall, all in-channel equipment and/or diversion structures shall be removed. Exposed soils in upland areas will be stabilized via hydroseeding or with erosion control fabric/blankets. Significant rainfall is defined as 0.5 inch of rain in a 24-hour period.
- Work on the upper streambanks of stream channels (e.g., vegetation, road, and v-ditch maintenance) may be conducted year-round as long as erosion and spill BMPs are implemented. Ground disturbing activities will only be conducted during periods of dry weather.

3.4.3.2 Staging and Stockpiling of Materials

- Staging will occur on access roads, surface streets, or other disturbed areas that are already compacted and only support ruderal vegetation to the extent feasible. Similarly, to the extent practical, all maintenance equipment and materials (e.g., road rock and project spoil) will be contained within the existing service roads, paved roads, or other pre-determined staging areas. Staging areas for equipment, personnel, vehicle parking, and material storage shall be sited as far as possible from major roadways.

- All maintenance-related items including equipment, stockpiled material, temporary erosion control treatments, and trash, will be removed within 72 hours of project completion. All residual soils and/or materials will be cleared from the project site.

- As necessary, to prevent sediment-laden water from being released back into waters of the State during transport of spoils to disposal locations, truck beds will be lined with an impervious material (e.g., plastic), or the tailgate blocked with wattles, hay bales, or other appropriate filtration material. If appropriate, and only within the active project area where the sediment is being loaded into the trucks, trucks may drain excess water by slightly tilting the loads and allowing the water to drain out through the applied filter.

- Building materials and other maintenance-related materials, including chemicals and sediment, will not be stockpiled, or stored where they could spill into water bodies or storm drains or where they will cover aquatic or riparian vegetation.

- No runoff from the staging areas would be allowed to enter waters of the State, including the creek channel or storm drains, without being subjected to adequate filtration (e.g., vegetated buffer, hay wattles or bales, silt screens). The discharge of decant water from any on-site temporary sediment stockpile or storage areas to waters of the State, including surface waters or surface water drainage courses, outside of the active project site, is prohibited.

- During dry season, no stockpiled soils shall remain exposed and unworked for more than 30 days. During wet season, no stockpiled soils shall remain exposed, unless surrounded by properly installed and maintained silt fencing or other means of erosion control.

- All spoils will be disposed of in an approved location. Sediments that are found to contain contaminants exceeding hazardous materials disposal criteria will be stockpiled separately on heavy plastic pending disposal at an appropriate hazardous materials disposal location.

3.4.3.3 Channel Access

- Access points to the channel for the purposes of channel maintenance will be minimized according to need. Access points should avoid large mature trees, native vegetation, or other significant habitat features as possible. Temporary access points shall be sited and constructed to minimize tree removal.

- In considering channel access routes, slopes of greater than 20% shall be avoided if possible. Any sloped access points will be examined for evidence of instability and either revegetated or filled with compacted soil, seeded, and stabilized with erosion control fabric as necessary to prevent future erosion.

3.4.3.4 General Measures

- Activities will avoid damage to or loss of native vegetation to the maximum extent feasible.

- Soil disturbance shall not exceed the minimum area necessary to complete the operations as described.

- At the beginning of each maintenance season and before conducting stream maintenance activities, all personnel will participate in an educational training session conducted by a qualified biologist.[26] This training will include instruction on how to identify special-status species that may occur in the work areas, and the appropriate protocol if any listed species are found during project implementation.

- Personnel who miss the first training session or are hired later in the season must participate in a make-up session before conducting maintenance activities.
- If hydraulic conditions allow, the natural streambank will be retained or a biotechnical repair technique will be used rather than, or along with, a hardscape repair.
- If there is the potential for the spread of invasive species between watersheds all equipment will be appropriately decontaminated between use utilizing methods consistent with CDFW's Aquatic Invasive Species Decontamination Protocol.[27]

3.4.3.5 Vegetation Management

- Vegetation pruning and removal activities will be conducted under the guidance of a staff biologist, certified arborist, or other vegetation specialist who will be on site to help direct maintenance activities and to consult if questions and/or issues arise.
- Vegetation that is noxious, invasive, hazardous, a public safety or fire concern, or could obstruct channel flows will be removed as appropriate. Herbaceous layers that provide erosion protection and habitat value will be left in place. Invasive plant species that inhibit the health and/or growth of native riparian trees will be targeted for removal.
- Where a choice between species that may be removed to maintain flood conveyance is feasible, slower-growing species such as oaks (*Quercus* spp.) that develop large canopies will be preferentially preserved, because these species take longer to establish, and provide essential nesting habitat for cavity nesters and food sources for a variety of resident and migratory animals. Faster-growing species such as alders (*Alnus* spp.) and cottonwoods (*Populus* spp.) are the second priority for preservation; these single-trunked species offer the benefit of improved flood conveyance and reduced roughness by comparison with multi-trunked species.
- Vegetation will be removed and/or pruned in such a manner that channel roughness is reduced while allowing the maximum amount of vegetation to remain in place. Trees will be trimmed or pruned to reduce impedance of flood flows while allowing the canopy to develop. Specifics for each site will differ, but typical options include limbing to remove lower branches that have potential to interfere with flood flows, and pruning into a "fan" roughly parallel to flow direction. In areas where extensive vegetation removal is desirable to maintain flood flow capacity, phasing of removal shall be considered so that some vegetation may remain in place to provide habitat to birds.
- Vegetation management will emphasize the preservation of large mature trees that provide well-developed overstory for bird habitat, canopy closure for stream shading, and add vertical complexity to the riparian corridor. Vegetation management will be conducted in such a manner that maximizes shading over the active channel. Where vegetation is removed from

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[26] A qualified biologist (including those specializing in botany, wildlife, and fisheries) is determined by a combination of academic training and professional experience in biological sciences and related resource management activities. Sonoma Water may also utilize appropriately experienced and/or trained environmental staff. Resumes will be submitted to CDFW, USFWS and/or NFMS for approval prior to commencement of biological surveys, as stated in CDFW, USFWS and NMFS permit conditions.

[27] CDFW, 2022. Aquatic Invasive Species Decontamination Protocol. October 3.

the active channel, removal will target nonnative species and removal of native species that are stiff and/or multi-trunked such as arroyo willow (*Salix lasiolepis*). Trees will never be topped as this encourages shrubby growth and weak branch attachments.

- Large woody debris, stumps, or root wads that are fully or partially buried and do not present a flood hazard shall be allowed to remain in place to provide habitat and to maintain streambank stability. Removal of logs and debris from streams will be a “last resort” when accumulation of debris poses a threat to stability of structures including roads, bridges, and culverts.

- Modifications and/or removal of large woody debris will be limited to material that extends higher than ~approximately 2 feet above the streambed to preserve some instream habitat features unless the log or debris jam is immediately upstream and threatening a culvert or bridge.

- To the extent feasible, removed native vegetation shall be saved to replant after maintenance or planted in other nearby sites. This includes the reuse of mulch and willow sprigs where possible.

- All herbicide use shall be consistent with all Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) label instructions and any use conditions issued by the Sonoma County Agricultural Commissioner.[28]

- Herbicide use will be restricted to the minimum amount needed to ensure adequate control of vegetation.

- Application of herbicides to upland areas shall not be made within 72 hours of predicted rainfall.

- Herbicides will not be directly applied to waters of the U.S., such as for water primrose (*Ludwigia* sp.) eradication.

- As required by the Court-Ordered Stipulated Injunction for pesticide use near Pacific salmon-supporting waters in Sonoma County, pesticides specified in the injunction including 1,3-dichloropropene, bromoxynil, carbaryl, chlorpyrifos, diazinon, malathion, methomyl, metolachlor, and prometryn, will not be used within 20 yards of salmon-supporting waters. Sonoma Water will review the details and exceptions in the court order and comply with the herbicide use buffers as appropriate.

- Sites where maintenance activities result in exposed soil will be stabilized to prevent erosion and revegetated with native vegetation as soon as feasible after maintenance activities are complete.

- Revegetation will occur at a ratio of at least 1½: 1 to account for initial mortality of plantings.

- If soil moisture is deficient, new vegetation will be supplied with supplemental water until vegetation is firmly established.

- To the extent possible, native grass seed will be used when seeding a project site.

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[28] Currently, Sonoma County applies AquaMaster®, which contains glyphosate as the active ingredient, to access roads along Sonoma Water-maintained channels.

- Erosion control fabric, hydromulch, or other mechanisms will be applied as appropriate to provide protection to seeds, hold them in place, and help retain moisture.
- Revegetation shall be regularly monitored for survival at five years or until minimum survival/ cover is achieved. If invasive species colonize the area, action shall be taken to control their spread; options include hand and mechanical removal and replanting with native species.

3.4.3.6 Water Quality and Channel Protection

- Upland soils exposed due to maintenance activities will be seeded and stabilized using erosion control fabric or hydroseeding. The channel bed and other areas below ordinary high-water mark are exempt from this BMP.
- Erosion control fabric will consist of natural fibers that will biodegrade over time. No plastic or other non-porous material will be used as part of a permanent erosion control approach. Plastic sheeting may be used to temporarily protect a slope from runoff, but only if there are no indications that special-status species would not be impacted by the application.
- The site will be properly prepared to make sure the fabric/mat has complete contact with the soil. Sites can be prepared by grading and shaping the installation area; removing all rocks, dirt clods, vegetation, etc.; preparing the seedbed by loosening the top 2 to 3 inches of soil; and applying soil amendments as directed by soil tests, the seeding plan, and manufacturer’s recommendations.
- The area will be seeded before installing the fabric. All areas disturbed during installation will be re-seeded.
- Erosion control fabric will be anchored in place. Anchors can include U-shaped wire staples; metal geotextiles stake pins or triangular wooden stakes.
- Other erosion control measures shall be implemented as necessary to ensure that sediment or other contaminants do not reach surface water bodies for stockpiled or reused/disposed sediments.
- After sediment removal, the channel shall be graded so that the transition between the existing channel both upstream and downstream is smooth and continuous between the maintained and non-maintained areas and does not present a “wall” of sediment or other blockage that could erode once flows are restored to the channel.
- Where pre-maintenance channel form exhibited desirable features, the channel bed will be regraded to mimic the channel form before work was conducted.
- Where possible, grading may include channel enhancements such as excavation of a low flow channel, development of a meander, or riffle/pool configurations.
- If gravels that have the potential to be utilized for spawning are removed to conduct maintenance activities, the gravels will be carefully removed and stored where maintenance activities will not impact the quality of the gravel. The gravel shall be replaced as close to original conditions as possible upon completion of the maintenance activities. Site selection and instream gravel placement will be implemented in coordination with NMFS and CDFW.
- Where in-stream gravel and gravel (or cobble) bars are encountered, sediment removal activities will aim to preserve the overall shape and form of the existing bar or gravel feature.

Sediment removal activities will aim to retain the form of the gravel or cobble bar feature, while reducing bar elevations as necessary to accommodate flood conveyance capacity.

3.4.3.7 Salmonid Protection Measures

- Sonoma Water shall isolate work areas located in aquatic habitat from the flowing stream and relocate listed salmonids prior to proceeding with in-channel work for channel maintenance or habitat enhancement. Sonoma Water will:
  - Retain a qualified biologist with expertise in anadromous salmonid biology;
  - ensure the biologist is onsite during all dewatering events;
  - ensure all captured salmonids are properly cared for;
  - contact the Santa Rosa Area NMFS and CDFW office immediately if any salmonids are found dead or injured; and
  - allow NMFS and CDFW staff or persons designated by the resource agencies to be on-site during dewatering activities.
- At all channel maintenance sites, Sonoma Water will:
  - Check construction equipment for leaks each day prior to conducting work in the channel;
  - ensure all fill material for cofferdams is fully contained;
  - ensure all diversion pumps are screened in compliance with NMFS' and CDFW's fish screening criteria;
  - ensure pump screens are periodically monitored for the impingement of aquatic species;
  - ensure that cofferdams are properly sized and maintained throughout the duration of maintenance activities; and
  - ensure that all material is removed after completion of the project.
- Sonoma Water will provide NMFS and CDFW with reports on construction-related and fish relocation activities by February 15 of the year following maintenance.
- Sonoma Water will reduce impacts on habitat complexity:
  - all work in natural channels, except for revegetation activities, will be conducted between June 15 and October 15;
  - no work will be started that cannot be completed before the onset of a storm event;
  - vehicles may be driven in the dry streambed only as necessary to accomplish work;
  - all exposed/disturbed areas on upper streambanks within the project site will be stabilized;
  - install erosion control measures to divert runoff to stable areas;
  - all new riprap will be planted with willows or other native trees;
  - no grouted riprap shall be installed;

  - bioengineering techniques shall be incorporated into all streambank stabilization projects; and
  - when grading gravel bars, a buffer shall be maintained.

- When site conditions allow, Sonoma Water will construct a low flow channel at sediment removal sites to provide enhanced migration habitat through sediment removal areas.
- Sediment removal project designs will be submitted to NMFS and CDFW 60 days prior to implementation for approval.
- The low flow channel shall be monitored at least two times in between large storm events.

3.4.3.8 Salmonid Relocation Measures

Sediment maintenance/removal and streambank stabilization activities may require dewatering and subsequent relocation of aquatic species. In most situations, such activities will only occur when the stream reach is completely dry or during the lowest flow of the season. In the event that the channel is conveying flow or ponding water during proposed channel maintenance activities, the following dewatering and fish relocation measures will be implemented:

- A cofferdam, pump station, and re-routing pipeline will be used to dewater a short section of channel at a time. The following dewatering measures will be employed:
  - An inflatable cofferdam will be used primarily; however, under some circumstances (e.g., inside large culverts), the cofferdams will be constructed using sand or gravel;
  - Pumping rates will be consistent with the existing stream flow to bypass water around the work site;
  - Pump intake lines will be protected with screens according to NMFS and CDFW criteria to prevent the entrainment of aquatic species;
  - Bypass flows will be released back into the channel near the downstream end of the project area; and.
  - Silt bags will be used at the end of the diversion pipe to reduce any sediment discharge downstream and to dissipate flow velocity and prevent scour at the discharge site.
- Before and during the dewatering of a work area, fish will be captured and relocated to avoid injury and mortality and minimize disturbance. The following guidelines will apply:
  - Before fish relocation begins, a qualified biologist will identify the most appropriate release location(s). Release locations will have water temperatures within 1 degree Celsius (°C) of the capture location and offer ample habitat for released fish and should be selected to minimize the likelihood that fish will reenter the work area or become impinged on the exclusion net or screen.
  - The means of capture will be site-dependent and will be selected by a qualified fish biologist who is experienced with fish capture and handling. Complex stream habitat may require the use of electrofishing equipment. Electrofishing will be conducted only by trained personnel following NMFS guidelines dated June 2000.
  - Handling of salmonids will be limited to permitted personnel. If necessary, personnel will wet hands or nets before touching fish.

  - Fish will be held temporarily in cool, shaded water in a container with a lid. Aeration will be provided with a battery-powered external bubbler. Fish will be protected from jostling and noise and will not be removed from the container until the time of release. A thermometer will be placed in each holding container and partial water changes will be conducted as necessary to maintain a stable water temperature. Fish will not be held more than 30 minutes.
  - If fish are abundant, capture will cease periodically to allow release and minimize the time fish spend in holding containers.
  - Fish will not be anesthetized or measured but will be visually identified to species level, and year classes will be estimated and recorded.
  - Any salmonids captured will be scanned for Passive Integrated Transponder (PIT) and/or coded wire tags.
  - When feasible, initial fish relocation efforts will be performed several days prior to the scheduled start of construction.
  - Reports on fish relocation activities will be submitted to CDFW and NMFS in a timely fashion.
  - If mortality during relocation exceeds 2% per species, relocation will cease and CDFW and NMFS will be contacted immediately or as soon as feasible.

3.4.3.9 Other Measures

- Where the pre-maintenance channel form exhibits desirable features, the channel bed will be regraded to mimic the pre-maintenance channel form. Modification of instream structures that are determined to benefit aquatic species during high water and/or high velocity events will be avoided during maintenance activities. If these structures are determined to be a detriment to flood conveyance, Sonoma Water will work with NMFS and CDFW to either modify or relocate the structure (if possible).
- Where possible, grading may include channel enhancements (e.g., excavation of a low flow channel, development of a meander, or riffle/pool configurations).
- For focused sediment removal activities, where in-stream gravel or cobble bars are encountered, sediment removal work will aim to preserve the overall shape and form of the existing bar or gravel features.
- After sediment removal work, the channel will be graded so that the transition between existing channel both upstream and downstream is smooth and continuous between the maintained and non-maintained areas.

3.5 Central Sonoma Watershed Project

Sonoma Water has operated and maintained engineered and modified channels and flood control facilities for several decades; many of which were initially constructed as part of the Central Sonoma Watershed Project (CSWP). The 1958 CSWP Work Plan described facility and channel maintenance as follows:

> *The Flood Control District [now Sonoma Water] will assume full responsibility for operating and maintaining all structural works of improvement installed*

> *under this plan in such a manner that they will serve the purpose for which they were installed, to the degree for which they were designed.*[29]

Importantly, the CSWP reservoirs operate passively, i.e., they were constructed to require no operational activity (e.g., turning valves, lifting gates, or adjusting releases) to achieve flood protection goals. Thus, maintenance activities at these reservoirs, and other CSWP facilities, including the Santa Rosa Creek diversion structure, consists mainly of sediment and vegetation management. These maintenance actions are covered under the SMP biological opinion and are not included as part of the Proposed Action.[30] Under the Proposed Action, Sonoma Water will continue to passively operate CSWP facilities, including the Santa Rosa Creek diversion structure, and operate the recently constructed bypass pipe at the Santa Rosa Creek diversion structure.

3.5.1 Santa Rosa Creek Diversion Structure

In 2021, the diversion structure's Vortex Tube (submerged flow-regulating culvert) underwent a series of repairs, which included the installation of a bypass pipeline to facilitate future maintenance and inspection (see Section 4.3.5.3, *Santa Rosa Creek Diversion Structure*). As part of this process, Sonoma Water reaffirmed with NMFS that the *2008 Biological Opinion* provided an adequate description of incidental take as to authorize continued operation of the facility.[31]

Bypass Pipe operation consists of removing the caps on both ends of the pipe located at the head walls and installing a cofferdam across Santa Rosa Creek between the inlet of the pipe and the fish ladder. As water depths increase behind the cofferdam, creek flows enter the Bypass Pipe and isolate the Vortex Tube and fish ladder structures. Flows exiting the Bypass Pipe are directed along an earthen ditch before returning to the Santa Rosa Creek channel. Removal of sediment from the earthen ditch may be necessary before operating the Bypass Pipe. Also, pumps are used to dewater the Vortex Tube once flows are diverted through the Bypass Pipe.

Under the Proposed Action, Sonoma Water would continue to operate the Santa Rosa Creek diversion structure. During normal operating conditions, Santa Rosa Creek flows would pass through the Vortex Tube and the Bypass Pipe ends would be closed. The Bypass Pipe would only be placed into operation during Vortex Tube repair work to allow periodic future inspections of the integrity of the Vortex Tube if visible damage is observed, and to conduct maintenance, as needed. These inspections would require dewatering the Vortex Tube using cofferdams and operation of the Bypass Pipe that may take 1 to 2 weeks to complete.

3.6 Hatchery Facility Maintenance

The Coho Salmon broodstock and steelhead hatchery programs are currently authorized, or in the process of seeking authorization, under individual FESA section 10(a)(1)(A) enhancement permits. Since the effects of operation of the Coho Salmon broodstock program have already been analyzed

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[29] Sonoma County, 1958. Central Sonoma Watershed – Watershed Work Plan. Prepared by the Santa Rosa Soil Conservations District and the Sonoma County Flood Control and Water Conservation District. April.

[30] SCWA, 2021. *Op. cit.*

[31] SCWA, 2020. Vortex Tube Rehabilitation Project, Russian River Biological Opinion, and Incidental Take of Steelhead. Memorandum. November 5, 2020.

by NMFS in a July 2020 Final Environmental Assessment, and the federal permit for the broodstock program has been issued, the coverage of specific program elements will not be sought as part of the Proposed Action in this Biological Assessment.[32] While not complete, a similar development and regulatory approval process is underway for the steelhead hatchery program.

A series of deferred maintenance activities at the Warm Springs Hatchery are included as part of the Proposed Action. Foremost among these actions is the cleaning and potential dredging of the effluent pond at the WSD facility. In recent years the effluent pond has become increasingly impaired through the uninhibited growth of aquatic vegetation, and accumulation of detritus, which has caused increased sedimentation, impaired water quality, and reduced the effective storage volume of the pond.

Cleanup at the effluent pond will require an initial tree thinning and vegetation removal along the shoreline to provide access for maintenance equipment. The pipes that feed and drain the effluent pond would also be cleaned of vegetation and sediment buildup to maximize flow capacity. A long-reach excavator would then be brought in to remove overgrown aquatic vegetation and detritus within the pond. To the extent possible, direct contact with pond bottom would be avoided to prevent turbidity impacts. At this point it will be determined by USACE and CDFW staff as to whether dredging is required to return the pond to working condition. If dredging is found to be insufficient to address the issues of flow capacity at the effluent pond USACE and CDFW will explore resizing and replacing the outflow culvert to maximize flow capacity. It is proposed that shoreline vegetation management occur on a recurring on a 3- to 5-year cycle, with aquatic vegetation and detritus removal occurring annually at the discretion of USACE and CDFW staff. General repairs to facility infrastructure including rehabilitation of operational components and equipment would also be conducted as needed under the Proposed Action.

3.7 Dry Creek Habitat Enhancement

A detailed discussion on Dry Creek enhancement activities conducted since the publication of the *2008 Biological Opinion* is provided in Section 4, *Environmental Baseline*. Future construction on USACE's Dry Creek Ecosystem Restoration Project is scheduled to occur over the next four years (**Table 3-7** and **3-8**). The entire Dry Creek Ecosystem Restoration Project covers restoration sites located within eight river reaches, including reaches 1, 2a, 4b, 4c, 10 and 13a and 13b and will result in the restoration of approximately 4.2 km (47 acres) of habitat, once completed (see Figure 4-14 in Section 4, *Environmental Baseline*). When combined with the 5.5 km already completed under the *2008 Biological Opinion*, a total of 9.7 km of enhancement will have been completed in the 22.5 km of Dry Creek from Lake Sonoma to the mainstem Russian River to meet the requirements outlined in the *2008 Biological Opinion*. The construction timeline for all three phases listed below is limited within the environmental window, which is the allowable active construction season as determined by the resource agencies. The typical environmental window for Dry Creek allows for in-water work only between June 15 and October 15 in any

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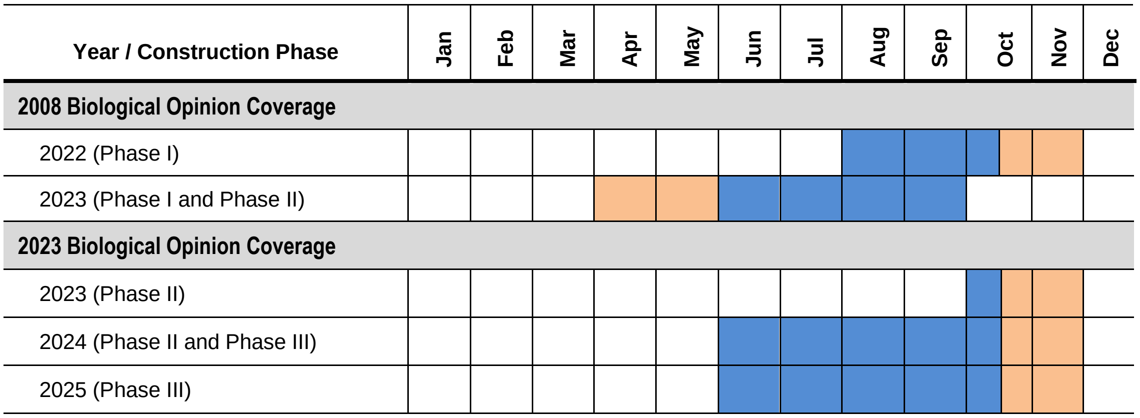
[32] NMFS, 2020. Final Environmental Assessment – Issuance of Endangered Species Action Section 10(a)(1)(A) Permit to the U.S. Army Corps of Engineers for Operation of the Russian River Coho Salmon Captive Broodstock Program at the Don Clausen Fish Hatchery. July 2020.

year.[33] The overall construction period for the entire project will take approximately four years and is targeted for completion in 2025, although delays related to real estate acquisition, weather and wildfire season may extend construction into 2026. Simultaneous construction in two reaches of the creek is expected to happen when Phase I and Phase II overlap (2023) and when Phase II and Phase III overlap (2024). Implementation during each phase may be conducted under multiple construction contracts (i.e., by different contractors). The phases of construction, the timelines and grouping of the reaches are shown below.

TABLE 3-7
DRY CREEK CONSTRUCTION STRATEGY AND ESA COVERAGE



Year / Construction Phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008 Biological Opinion Coverage												
2022 (Phase I)								🟦	🟦	🟦🟧	🟧	
2023 (Phase I and Phase II)				🟧	🟧	🟦	🟦	🟦	🟦			
2023 Biological Opinion Coverage												
2023 (Phase II)										🟦🟧	🟧	
2024 (Phase II and Phase III)						🟦	🟦	🟦	🟦	🟦🟧	🟧	
2025 (Phase III)						🟦	🟦	🟦	🟦	🟦🟧	🟧	

🟦 Primary Environmental Work Window: June 15 – October 15
🟧 Extended Environmental Work Window

SOURCE: USACE, 2022, pers. communication.

TABLE 3-8
DRY CREEK ENHANCEMENT CONSTRUCTION SCHEDULE

Reach/Subreach (Confluence to WSD)	Phase	Anticipated Construction Completion Date	River Kilometer from Confluence	Anticipated Dewatering Extent (ft)
1	VI (USACE GI Ph 3)	2025	0-1.1	815
2a	V & VI (USACE GI Ph 2 & 3)	2025	1.1-2.4	985
4b	III	2024	5.5	2,000
4c	V (USACE Ph 2)	2023	6.6	565
10a	IV (USACE Ph 1)	2023	15.8	795
10b	IV (USACE Ph 1)	2023	16.6	310
13a	IV (USACE Ph 1)	2023	18.8	145
13b	IV (USACE Ph 1)	2023	20.3	108

SOURCE: Sonoma Water and USACE, pers. comm. 2023.

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[33] USACE may seek an extension for the in-water work window to allow construction to occur in April, May, and November.

USACE-led restoration activities covered under Phases I, II, and III include the following reaches: 1, 2a, 4c, 10, 13a, and 13b. Additional restoration actions such as modifications and/or removal of existing grade control sills in Reaches 4b and 4c may be constructed during Phase III. Phase III will also include the Sonoma Water-led restoration project within Reach 5b. Additional sites beyond the reaches outlined above (e.g., the Sonoma Water-led restoration project within Reach 5b) may be necessary to meet the 9.7-km restoration requirement outlined in the *2008 Biological Opinion*. The USACE and Sonoma Water design efforts for these selected sites is a collaboration between Cardno (now Stantec), Inc., Environmental Science Associates, Inc. (ESA), and Inter-Fluve, Inc. To fully benefit from emerging scientific studies, new design methods, and positive outcomes of other previously restored projects, the design effort has been shared between firms with different innovative approaches in restoration site design to maximize ecosystem outputs. Moreover, after these sites are constructed, the success rate of the different design approaches will inform future restoration projects.

As in other USACE projects, all the design approaches used in future projects are made in strict conformance with the applicable USACE regulatory and engineering guidelines required for all the engineering products. The proposed design features described in the following sections have provided sufficient detail to plan and are at the 99 or the 100% level of design. All proposed features/structures include various LWM structures and pool/alcove structures. Separate from the USACE construction efforts, Sonoma Water is also pursuing an additional habitat project in the Reach 5b area of Dry Creek; however, due to landowner constraints, this project is indefinitely on hold..

3.7.1 Site Descriptions

Restoring varied habitats that allow for a multitude of salmonid life-history adaptations is critical for population resiliency. In addition, important steelhead and Coho Salmon spawning tributaries are distributed throughout the 22.5-km length of Dry Creek. The Dry Creek reaches can be sub-divided into three zones that share similar geomorphic characteristics: (1) the “Upper Segment” from the WSD to upstream of Pena Creek (Reaches 15 through 11); (2) the “Middle Segment” from Pena Creek to the end of backwater influence (Reaches 10 through 4a); and (3) the “Lower Segment” from the backwater influence zone to the Russian River confluence (Reaches 3b to 1; see Figure 4-14). By spreading out mainstem Dry Creek restoration within each of the three geomorphic zones, the project will increase favorable habitat availability to juvenile fish released into or originating in Dry Creek or emigrating from tributaries. General descriptions of the proposed enhancement sites are provided below with design plans available for download on Sonoma Water’s website.[34]

3.7.1.1 Reach 1

Baseline

Reach 1 is the most downstream enhancement reach of lower Dry Creek. Extending approximately 3,500 feet from the confluence with the Russian River upstream to the Mill Creek

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[34] https://www.sonomawater.org/dry-creek-habitat

confluence, Reach 1 is a single thread channel with a few vegetated gravel bars.[35] The channel currently alternates primarily between pools and flatwaters. There are six main channel and two side channel riffles in this reach that range in length from 40 to 80 feet. The reach also has two side channels (150 feet or less in length) and four small, shallow alcoves. Although historical incision has occurred (the terraces are 10 to 15 feet above the channel bed), the channel is currently vertically stable. Because of the proximity to the mainstem of the Russian River, there are large deposits of fine sediment and debris in Reach 1 that form during high flow events on the Russian River. The Russian River provides grade control for this reach, but the backwater created by the Russian River in addition to the high sediment load from upstream and from Mill Creek causes aggradation. Compared with other reaches, Reach 1 contains much less woody debris and less instream cover and aquatic edge habitat. Most of the existing cover is provided by willows and other vegetation interacting with the water, and small woody debris.

Proposed Design

The proposed design aims to increase available summer rearing habitat and stream water velocity refugia for salmonids and takes advantage of tributary connectivity, channel forming processes, and the wide floodplain present in the reach. Major features of the proposed design include a secondary channel floodplain reconnection, and large wood habitat features.[36] The features are designed to maximize longevity, minimize maintenance, and take advantage of the dominant channel-forming processes to promote the development of naturally occurring geomorphic complexity.

3.7.1.2 Reach 2a

Baseline

Reach 2a is approximately 0.8 km long and directly upstream of Reach 1. It is dominated by flatwater habitat and a wide floodplain is present throughout the reach. Reach 2, including the Reach 2a portion, is relatively straight with riprap-armoring along the majority of the streambank. Like Reach 1, Reach 2a still has active channel forming processes and is heavily influenced by high flow backwater from the mainstem of the Russian River. The channel is currently vertically stable, but incised below a terrace 10-15 feet above the channel bed. There are few gravel bars and no islands in this reach. Existing off-channel features include two narrow alcoves and one narrow side channel. Most instream cover is provided by terrestrial vegetation interacting with the water and secondarily by small woody debris. In the alcoves, aquatic vegetation provides additional cover, and the side channel is surrounded by thick overhanging riparian vegetation.[37]

Proposed Design

The design for Reach 2a is subdivided into upstream and downstream segments. The proposed design focuses on increasing the complexity of the channel by creating a more sinuous channel with riffle-pool sequences and significant backwater habitat. The proposed design seeks to enhance aquatic habitat quality and diversity by realigning the mainstem channel and adding

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[35] SCWA and USACE, 2019. Dry Creek Ecosystem Restoration Final Feasibility Report and Environmental Assessment. General Investigation, Sonoma County, California.

[36] Cardno, 2020. Dry Creek Ecosystem Restoration Project: Reaches 1 and 2A. 90% Draft Design Report. February 2020.

[37] Sonoma Water and USACE, 2019. *Op. cit.*

backwater alcoves that provide both juvenile salmonid summer rearing habitat and high-velocity winter refugia for adults. Winter refuge habitat would be enhanced by lowering the adjacent floodplain and adding large wood structures (see Section 3.7.4, *Large Wood Structures*) both in the low-flow channel and the floodplain. The design seeks to provide additional sinuosity and a more diverse main channel profile, introducing pool-riffle sequences to the existing flatwater.[38]

3.7.1.3 Reach 4b

Baseline

Reach 4b is located in the Middle Segment of Dry Creek, characterized by the increased sediment and surface water contributed from tributaries. It is bounded by two of the three grade control sills constructed along Dry Creek by USACE in 1983 to slow migrating nick points and associated channel incision. At the downstream boundary of the reach is the "middle" sill which is a grouted rock sill 200 feet long, 10 feet wide, and 3 feet high. At the upstream boundary of the reach is the "upper" sill which consists of a cascade down two sets of boulder falls, 2 feet and 1 foot in height. The "lower" sill is located in Reach 4a, which was modified by the USACE in 2018. Rock riprap covers the right bank[39] of Reach 4b between the upper and middle sills, and short sections of boulder riprap cover both banks upstream and downstream of each sill. Because of the sills, reach 4b has a relatively low level of sinuosity compared to other sections of Dry Creek, is vertically stable, and has large backwatered pool/flatwater areas created by each sill. The upper and middle sills each contain a fish ladder to provide passage through the short cascades.

The floodplain throughout Reach 4 is approximately 3 to 4 feet above the channel and adjacent terraces are 10 to 15 feet above the channel bed. There are two existing side channels in Reach 4b just below the upper sill. There are also three existing narrow, shallow alcoves: two by the upper sill and one just upstream of the middle sill. Relative to other reaches, Reach 4 had a high density of woody debris. Overhanging terrestrial vegetation provides instream cover along with woody debris. The understory vegetation in this reach is relatively dense and dominated by blackberry and grape.[40]

Proposed Design

At present no habitat features are proposed as part of enhancement work at Reach 4b. Proposed work within this reach would address low-flow passage at the upper and middle sills by lowering and notching both structures, or by installing a series of rock weirs downstream of each sill to bring the grade up over a longer distance to address passability issues at the sills..

3.7.1.4 Reach 4c

Baseline

Reach 4c is approximately 750-foot-long and is located immediately upstream of the upper-most grade control structure (the "upper" sill) that delineates the upstream end of Reach 4b. The channel has a moderate level of sinuosity and is flanked by relatively wide floodplain areas. It has

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[38] Cardno, 2020. *Op. cit.*

[39] The descriptive terms *right bank* and *left bank* refer to the perspective of an observer looking downstream.

[40] Sonoma Water and USACE, 2019. *Op. cit.*

significantly narrowed and incised since construction of WSD. Short sections of boulder riprap cover both streambanks upstream of the upper sill and this reach consists largely of a backwatered pool/flatwater area. The floodplain throughout Reach 4 is approximately 3 to 4 feet above the channel and adjacent terraces are 10 to 15 feet above the channel bed. There are two existing narrow, shallow alcoves in the reach. Relative to other reaches, Reach 4 has a high density of woody debris, instream cover provided by overhanging terrestrial vegetation, and dense understory vegetation dominated by blackberry and grape.[41]

Proposed Design

There are significant areas suitable for off-channel habitat creation in Reach 4c to support both summer rearing and winter high flow refugia habitats. The restoration design proposes two backwater alcoves with a series of lateral connections and narrow backwater connections. Reach 4c will also contain a series of inlet plug structures in the backwater alcove lateral connections to allow freshwater inflows during base flows to improve water quality, while inhibiting sediment input during high flows. Additionally, a series large wood structures including forcing wood, habitat wood, and topple tree structures, will be constructed within, and adjacent to, backwater alcoves to provide energy dissipation and rearing habitat cover.[42]

3.7.1.5 Reach 5b

Baseline

Reach 5b lies within the Middle Segment of Dry Creek, upstream and outside of the influence of the Russian River’s backwater influence. As a result, there is a balance between the volume of sediment entering and leaving the reach, though sediment may be redistributed from eroding banks to deposit on channel bars. The riparian corridor is relatively narrow in the upstream half of this reach, with a long straight channel alignment with little to no planform or bedform variability. The downstream half of Reach 5b widens to a larger corridor with a more sinuous alignment. A severe outside bend on the river left bank is actively migrating toward the vineyard. Several approaches for stabilization and erosion protection including placement of rubble and car bodies and installation of a wire mesh and steel beam fence have been attempted along this bank. The main channel is well-shaded by a continuous tree canopy.

Proposed Design

Restoration actions at Reach 5b include creation of perennial backwater alcoves, widening the main stem, and biotechnical bank stabilization on the left bank of Dry Creek. The existing floodplain terrace will be lowered to create three backwater alcoves with multiple summer baseflow connections to the main stem. Approximately 300 linear feet of the main channel will be widened to enhance an existing riffle. Within the project footprint, car bodies and debris along the left bank will be removed. At the downstream end of the project, the eroding scarp on the left bank will be stabilized with a large wood, rock, and willow-planted revetment. As noted above, due to landowner constraints, this project is indefinitely on hold.

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[41] Sonoma Water and USACE, 2019. *Op. cit.*

[42] Environmental Science Associates (ESA), 2022. Dry Creek Ecosystem Restoration General Investigation Phase II – Reaches 2a and 4c. 99% Design Report.

3.7.1.6 Reach 10

Baseline

Reach 10 falls in a segment of Dry Creek characterized by the increased sediment and surface water contributed by tributaries. Canyon Road Creek flows into the upstream portion of this reach on the left streambank, while an unnamed tributary flows into the downstream portion of the reach on the right streambank. The upstream portion of the reach contains some existing pool and riffle complexes and a large grassy floodplain bench on the right streambank of the river. In this portion of the reach, there is an approximately 250-foot steel I-beam erosion control structure with chain-link fencing that was installed by USACE post-construction of WSD in the left streambank and riprap placed along the terrace on the right streambank. The middle portion of Reach 10 is comprised of pool and flatwater habitat with some existing riffles and has a somewhat narrower floodplain than the upstream and downstream ends. There is an existing high-flow side channel on the right streambank in this section. The lower portion of Reach 10 contains some instream habitat complexity with riffles, a long alcove, and existing large wood. This section has a relatively wide floodplain. There is a significant amount of riprap that was placed to arrest an active meander approximately 600 feet from the downstream end of the reach. Also, along the downstream end of the reach the tall left streambank is covered with dumped dead grapevines. In general, instream cover in Reach 10 is limited to the side channel and alcove and primarily provided by woody debris and overhanging terrestrial vegetation.

Proposed Design

The restoration design for Reach 10 proposes four side channels, (two on the right streambank and two on the left streambank of the main Dry Creek channel), backwater features, biotechnical streambank stabilizations and high-flow channels to increase diversity, quality and quantity of juvenile summer rearing, and winter refugia habitat. In the upstream portion of the reach, one 950-foot-long side channel is proposed on the right streambank in the existing grassy terrace area. In the downstream section of the reach, an 800-foot side channel is proposed on the left streambank to provide a shortcut flow path in the sharp bend of the main channel. Winter refugia habitat and backwater habitat to enhance connection to the unnamed tributary are proposed on left and right streambanks of the main channel bend in this section. Planted slopes and large wood structures are proposed throughout the side channels and backwater habitats. Additionally, large wood structures, pool enhancement, and riffle construction are proposed to improve habitat in the main channel.

3.7.1.7 Reach 13a

Baseline

Reach 13a extends from just below the confluence with Fall Creek at its upstream end down to just downstream of the Dutcher Creek confluence at its downstream end. It is located in the Upper Segment of Dry Creek and receives little sediment from upstream due to the lack of significant tributary inputs and the discontinuity in sediment transport resulting from the installation of the dam. This section of Dry Creek has a relatively narrow active floodplain, and a channel geometry that lacks sinuosity and diversity due to the history of incision in Dry Creek. Rock riprap has been placed on the right streambank upstream of the Dutcher Creek confluence. The channel mostly contains pool and flatwater habitat with two existing riffles. There are two small alcoves and no existing side channels in this subreach. However, there is a floodplain area on the left streambank. Vegetation growth in the area indicates that there has been narrowing of the channel and vegetation encroachment along the active channel margins since construction of WSD.

Proposed Design

The primary feature in the restoration design for this reach is a perennial side channel constructed on the left streambank. The channel will have two openings to the mainstem and be approximately 600 feet long. The combination of side channel and LWM structures will serve mainly to provide summer rearing habitat. A riffle is also proposed within the side channel. No main channel enhancement is proposed in Reach 13a.

3.7.1.8 Reach 13b

Baseline

Reach 13b is located immediately upstream of Reach 13a and extends upstream 2,000 feet. It is characterized by a flow constriction as the channel passes through a straight, long riffle flanked by a riprap streambank on the left streambank. This reach, which is located upstream of all but one small tributary to Dry Creek, the channel planform and location has remained relatively stable since the dam was built. There are two existing relatively large riffles in this reach, one alcove, and no side channels. At the upstream end of the reach, a short section of rock riprap has been placed along the left streambank. The age of trees along the relic channel boundaries date back to the approximate time of dam construction.[43] Trees located close to the current channel boundary are younger than trees along the historic channel margins, indicating that narrowing and vegetation encroachment along the active channel margins has occurred.

Proposed Design

Enhancement in Reach 13b would include both main channel and off-channel habitat features. An approximately 700-foot-long side channel is proposed on the left streambank of the channel. At the upstream end of the side channel, there will be winter high flow refugia habitat. LWM structures would be placed throughout the side channel. There will be a greater amount of LWM placed at the two connections to the main channel to stabilize the openings and prevent erosion. The primary enhancement in the mainstem will be placement of a large boulder field.

3.7.2 Construction Phasing

The typical in-channel work period for the region is June 15 to October 15 to minimize impacts on migrating adult salmonids and to concentrate ground disturbing activity during the dry season. Any major ground disturbing activities would be limited to the typical dry season in-channel work period. Other work such as mobilization, staging, clearing, and grubbing at the sites may be conducted outside of this in-channel work-window as long as relevant BMPs are implemented. BMPs described in Section 3.4.2 would be implemented during enhancement construction when applicable. Due to this short annual construction window in which earthmoving activities near the channel can be carried out and the large size of the proposed restoration reaches, construction

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[43] Inter-Fluve Inc. 2012, Final Dry Creek fish habitat enhancement feasibility study: Conceptual Design Report, Sonoma County, July 2012.

would be phased over multiple consecutive years with groups of reaches constructed in different years. Such phasing is also expected to help minimize certain environmental effects by avoiding construction of all the reaches concurrently in a single year.

Under the Proposed Action, Reach 10, Reach 13a, and Reach 13b (approximately 1.6 km) would be constructed concurrently (with major earthmoving activities anticipated to occur between June 15 and October 15 of 2022 and 2023). Following completion of these subreaches, the upstream portion of 2a and Reach 4c (approximately 1.04 km total) would be constructed (with major earthmoving activities anticipated to occur between June 15 and October 15 of 2023 and 2024). Reach 1 and the downstream portion of Reach 2a (approximately 1.5 km total) would be constructed (with major earth moving activities anticipated to occur between June 15 and October 15 of 2024 and 2025). Phase III activities in 2024 and 2025 would include Sonoma Water's project at Reach 5b and potential additional restoration actions by the USACE. Construction could require additional seasons as the result of delays related to the presence of nesting birds or inclement weather.

3.7.3 Streambank Stabilization Measures

Once the off-channel features are constructed, biotechnical and geotechnical streambank stabilization measures will be placed on both the main and secondary channel slopes at bends and erosion prone areas. These stabilization measures would likely include brush mats made of biodegradable erosion control fabrics anchored by live willows stalking along the toe, hydro-seeding, and native plantings with minimal riprap placement along streambanks. Further refinements may be made to streambank stabilization structures and locations during the final design and construction phases.[44,45]

3.7.4 Large Wood Structures

Large wood structures of various types, sizes, and levels of complexity are proposed throughout each of the proposed project sites to help achieve a variety of habitat design objectives. Most of these large wood structures are immobile live or dead logs of different sizes assembled to serve various purposes in the restoration effort. Large wood features include log jams, log structures, and log habitat structures. For simplicity, these structures are referred to as large woody material (LWM) structures. LWM structures often function to affect channel hydraulics by modifying existing flows, diverting flows into side channels, or protecting channel banks. In addition to providing hydraulic benefits, these structures also provide fish habitat by creating localized scour holes, entrapping sediment, and providing hydraulic and escape cover for fish within the structure over varying flow regimes. These structures are often somewhat porous in design, especially near the water's edge, providing juvenile fish with opportunities to hide in and under the structure to avoid predators. Engineered LWM structures can vary from one to many logs strategically placed during construction to mimic naturally occurring log jams. These structures can serve different purposes over a range of flows. For example, a single LWM structure may promote localized

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[44] Cardno, 2020. *Op. cit.*

[45] ESA, 2022. *Op. cit.*

scour and pool formation over one flow range while backwatering flow to cause a secondary channel over another flow range.

Engineered large wood features typically include rootwads as an essential building block of LWM structures. Unlike downed logs in which the tree is sawed off near the base or stump, the tree is instead, pushed over, exposing the root mass or rootwad. The entire tree is left intact for transportation and implementation in LWM structures. Additional rootwads and logs are placed together in combination to form the LWM structure.

Ballast material is often included in LWM structures to combat against buoyance, over-turning, rotation, impact, and sliding forces when the structure is exposed to over varying flows. Ballast material consists of boulders, cobbles, and earthen fill along with other logs and pinning logs against one another. Pinning logs/posts can either be mechanically driven or excavated to act as vertical piles providing additional support and stability against expected forces (rotation for example). Adding mechanical hardware such as cables or through bolts provides greater stability and longevity to the structures; however, this adds inorganic and non-biodegradable materials to the stream environment.

3.7.4.1 Types of Large Wood Features Used in Designs

In order to achieve habitat enhancement objectives, multiple types of LWM structures are incorporated into the design of the enhancement reaches described above. These LWM structures include apex wood structures, forcing wood structures (deflectors), pool habitat wood, revetment wood structures, channel plugs, single log habitat structures, and toppled wood.

- **Apex Wood Structures**: These structures will be located at secondary channel inlets to split flow from the mainstem into the secondary channel. Apex structures will also be situated along straight reaches or partial bends tying into the mainstem channel banks causing localized scour and/or bank protection. Rootwads, protruding branches, and racking material will be located near the front of the structure to aid in additional wood/debris collection over time and provide additional roughness to promote localized scour. These structures will typically include four to eight logs in triangular configurations, with the apex of the triangle oriented upstream.

- **Forcing Wood Structure (deflector):** Forcing wood structures will be placed along outlet side channels and along the banks of mainstem Dry Creek to provide flow deflection, complexity, and eddies in areas where channel bed modifications are needed to break up long sections of simplified stream channel that currently exist. These structures will include rootwads, protruding branches, and racking material that will aid in eddy formation and additional wood/debris collection over time. Wood structures typically consist of interlocking trees with rootwads arranged both vertically and horizontally; rootwads of the horizontal members are angled toward the flow path and slightly elevated compared to the top of the tree end. These structures tend to be larger in size and typically consist of 10 rootwads and logs.

- **Pool Habitat Wood Structures:** Pool structures will be placed in and along stream sections in which there are slower velocity areas with minimal bank stabilization required. The addition of rootwads within these structures near pools and alcoves will provide resting areas for salmonids, create fish cover and provide shade during the summer months. These structures will be relatively small compared to the other LWM structure types discussed.

- **Revetment Wood Structures:** Revetment wood structures will be located along the outside bend of both the mainstem of Dry Creek and the outside bends of the secondary channels. The purpose of the revetment structure is to stabilize the vertical banks of an outside bend, limiting incision and erosion while also providing roughness and fish habitat. Rootwads incorporated into these LWM structures provide scour in and around the structures resulting in increased hydraulic forcing, increasing pool depth and cover within pools. The addition of the revetment log structures will limit further channel migration beyond the designed riparian channel corridor into private landowner parcels, by providing an engineered hard point.

- **Channel Plugs:** The purpose of a channel plug structure is to reroute and force the flow path of a long, straight section of Dry Creek's mainstem into a new channel that adds additional channel length and sinuosity. The new rerouted channel includes a riffle/pool channel complex currently lacking in the existing channel. Channel plugs do not include filling the existing channel downstream of the plug structure. Instead of filling the entire existing channel, the area downstream of each plug will remain as is and will be somewhat wetted through hyporheic connection and backwater conditions creating an alcove in the existing channel.

- **Single Log Habitat Wood Structures, Toppled Wood, and/or Floodplain LWM Structures:** Single log habitat structures, toppled wood, and/or floodplain LWM structures are all similar in design. Essentially, they refer to a downed tree with ballast or bracing. Single log habitat wood and toppled wood refer to structures located in or adjacent to waterways. Floodplain LWM structures are located on the floodplain and would only be wetted during higher flow events. The slight difference between toppled trees and single log habitat structures relate to the source location of tree procurement. Toppled trees refer to the use of an existing salvaged tree on-site, whereas a single log structure refers to a tree with a rootwad that is procured off-site. To provide additional roughness, shade, and habitat complexity, typical placement of these LWM structures is tends to be in slower velocity water areas (e.g., alcoves both within the mainstem and secondary channels).

3.7.5 Riffle Substrate and Boulder Fields

Boulder fields and riffle creation or enhancement will be included in some of the proposed project sites. The *2008 Biological Opinion* stated that in addition to channel modifications a minimum of 20 large boulder clusters be installed to support formation of riffle:pool sequences. To date, 19 boulder clusters and/or fields have been installed as part of the Dry Creek enhancement (see Section 4.4.4, *Dry Creek Enhancement*, for a description of completed enhancement work).[46] Boulder fields are installed to provide velocity refugia, hydraulic grade control and stabilization, and habitat for fish. Future boulder enhancements will consist of numerous 1 to 2-ton boulders placed together in the main channel. Engineered riffles are created by placing appropriately-sized riffle substrate across the main or side channels to control the bed and water surface elevation, create pools, enhance invertebrate production and feeding conditions, and augment spawning habitats. Riffle substrate consists of appropriately sized and graded layers of small boulders, cobbles, gravel, and sand.

3.7.6 Flow Diversions and Dewatering

During construction it will be necessary to partially or completely divert the stream around active work zones to construct the proposed restoration features and prevent excessive turbidity to the

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[46] D. Cuneo, Sonoma Water, pers. comm., July 26, 2023.

active flowing stream. Based on previously constructed reaches, partial flow diversion will be required during the installation of some large wood structures, large-scale streambank stabilizations along the mainstem, and excavation of secondary channel or alcove connections to the main channel. Cofferdams made of gravel bags or sheet piles will be used to isolate the work area from the main channel. Dewatering isolated areas with portable pumps into a detention basin may also be used in combination with the cofferdams. Such dewatering is required when embedded log structures are anchored to ballast boulders. Though fully diverting the main channel and bypassing an entire work zone in a reach is unlikely, the contractor may choose this option if necessary. As necessary, all aquatic fish and wildlife will be relocated before areas are dewatered or work in an area begins.

3.7.7 Vegetation Management

Vegetation management will consist primarily of removing invasive species, protecting key native vegetation, and planting additional natives. The following summarizes the key specifications for revegetation and vegetation management:

- High-priority native vegetation to be protected includes large, mature trees, snags, and native understory where it is robust and preventing the establishment of invasive species. The protected vegetation will continue to provide shade and other riparian habitat benefits.
- Where feasible, trees to be removed for construction will be salvaged and incorporated into the planned large woody debris structures for added complexity. It is anticipated that some wood retrieved from clearing during construction can be reused for habitat enhancement, although most designs will import conifer logs. Willows and cottonwoods can be used for live wood structures and other species such as rushes and sedges may also be salvaged and transplanted after construction.
- Planting of native vegetation will occur in all graded areas outside of active baseflow channels. The highest priority planting sites include locations where new channel construction will result in warm, exposed conditions, areas that require erosion control, and areas of invasive removal that require native plantings to help prevent reestablishment of invasive. Vegetation planting will occur immediately after construction. Typically, plants begin to provide shade to the channel within a few years of being installed.
- High priority invasive-species removal includes those plants that are detrimental to habitat conditions, are currently limited in extent but have high potential to spread or both. These will be removed by mechanical means prior to or during construction in all graded areas. Invasive removal may extend beyond the graded area to reduce the likelihood that reestablishment will occur. Also, isolated occurrences of highest priority species such as arundo (*Arundo donax*) may be removed. Approximate extents of invasive removal beyond graded areas will be identified on the project plans during the design phase and exact boundaries will be determined in the field.

3.7.8 Post-Construction

Following construction, enhancement sites will be managed under an Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) Plan and Monitoring and Adaptive Management Plan (MAMP). These two programs will occur concurrently, with the Joint Monitoring Team (JMT) deciding which activity is appropriate if the project suffers any damage or is not meeting objectives. In general, OMRR&R will restore the project to its as-constructed condition and adaptive management will result in changes to the as-constructed project design to better meet project objectives.

3.7.8.1 Operations and Maintenance

Only limited OMRR&R requirements are desirable for ecosystem enhancement projects because they are designed to be self-sustaining. The USACE and Sonoma Water have emphasized their interest in designing and implementing the project to minimize the need for major rehabilitation. However, periodic maintenance to remove accumulated sediment or adapt to changing channel conditions that result from high winter flows is anticipated. After construction and the 10-year monitoring and adaptive management period, Sonoma Water will assume Operations and Maintenance (O&M) responsibility for the entire project footprint. The non-Federal sponsor is responsible for all long-term project OMRR&R following completion of construction. A detailed O&M manual will be developed for each site during the Project design and implementation phases.

The O&M plan will include the following activities:

- **Inspection of features will occur after completion of construction**. Follow-up inspections will occur annually after geomorphically effective flows occur (i.e., flows that mobilize sediment) or within 3 years of completion.
- **Vegetation Maintenance**. Removal of non-native vegetation and managing vegetation for habitat needs will be conducted as needed. Frequency of work depends on vegetation growth, but typically occurs every 2-5 years. Vegetation maintenance at a site typically requires a team of five two days to conduct.
- **Structure maintenance**. Minor erosion control repair and excavation around LWM structures will occur as necessary. Structure maintenance activities would require a team of five two days to conduct, approximately every 3 years.
- **Habitat Feature Maintenance**. Removing sediment, repairing/stabilizing erosion, or adapting features to changing channel conditions, as needed during the O&M phase.

3.7.8.2 Adaptive Management

The Dry Creek Ecosystem Restoration Project Monitoring and Adaptive Management Plan (MAMP) was developed by USACE and describes in detail how USACE will monitor and adaptively manage to ensure project benefits.[47] It includes costs, schedule, monitoring metrics and targets, success criteria, and potential adaptive management measures. This MAMP (2019) dovetails with a 2014 document prepared by Sonoma Water, NMFS, CDFW, USACE, and ESSA Technologies that set up an adaptive management process for ecosystem restoration projects constructed on Dry Creek to meet the goals of the RPA in the *2008 Biological Opinion*. While based on the methods outlined in Sonoma Water's Adaptive Management Plan (AMP), USACE's MAMP is a standalone document, intended to define adaptive management actions related to USACE's Dry Creek Ecosystem Restoration Project. USACE's Ecosystem Restoration Project is technically independent of the *2008 Biological Opinion* but is designed to meet the restoration

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[47] USACE, 2019. Monitoring and Adaptive Management Plan – Dry Creek Ecosystem Investigation Study. Final Integrated Feasibility Report and Environmental Assessment.

objectives outlined in that document. For the purposes of satisfying the *2008 Biological Opinion*, Sonoma Water will continue to use the AMP (2014) for ongoing monitoring at completed restoration sites, while the MAMP will be used for future monitoring related to USACE's Dry Creek Ecosystem Restoration Project. For a discussion of completed Dry Creek restoration please see Section 4.4.4, *Dry Creek Habitat Enhancement*.

Both the MAMP and AMP describe monitoring activities that will allow USACE and Sonoma Water to determine if projects are successfully meeting restoration objectives. The MAMP and AMP also lay out a framework for deciding when and how to modify project designs and implement fixes if the project is not meeting these objectives. The adaptive management cycle outlined in both documents involves synthesizing existing knowledge, exploring alternative actions, making explicit predictions of outcomes, selecting one or more actions to implement, and monitoring to see if the outcomes match predictions. The final steps include using what is learned from the preceding steps to change future management policy and plans. Sonoma Water's and USACE's level of compliance with the *2008 Biological Opinions* RPA for Dry Creek involves examination of data from implementation, effectiveness, and validation monitoring of enhancement projects. The process of combining monitoring data stems from first selecting a stream reach for enhancement then developing enhancement designs given geomorphic and landowner constraints. Once these designs are agreed to by Sonoma Water, USACE, NMFS, and CDFW, enhancement projects are implemented, and monitoring can be initiated.[48]

Types of Monitoring

Three types of monitoring (implementation, effectiveness, and validation) as defined in the RPA are conducted to characterize the success and determine the next course of action for enhancement projects. Physical habitat responses (e.g., changes in depth, velocity, shelter) can be more directly linked to habitat enhancement actions than can biological responses which may be subject to complex factors outside of human control (e.g., seasonal rainfall patterns, ocean conditions, etc.) that will affect salmon and steelhead survival and abundance on an annual basis. Additionally, it may take a considerable length of time and a considerable amount of habitat enhancement to produce and detect a measurable biological response.[49,50] For these reasons, once project conditions are documented and approved via implementation monitoring, effectiveness monitoring of improvements in physical habitat is the primary means whereby the results of fish habitat enhancements in mainstem Dry Creek are credited.

Implementation Monitoring

Implementation monitoring is aimed at determining if the habitat enhancement was done according to the approved design. In other words, *did the contractor/builder do what they said they were going to do?* Implementation monitoring occurs immediately post-construction and serves as a

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[48] Porter, M., D. Marmorek, D. Pickard, and K. Wieckowski, 2014. Dry Creek Adaptive Management Plan (AMP). Prepared by ESSA Technologies LTD., Vancouver, CB. Prepared for Sonoma Water.

[49] Bradford, M.J., J. Korman, and P.S. Higgins. 2005. Using confidence intervals to estimate the response of salmon populations (Oncorhynchus spp.) to experimental habitat alterations. Canadian Journal of Fisheries and Aquatic Sciences 62: 2716-2726.

[50] Roni, P., G. Pess, T. Beechie, and S. Morley. 2010. Estimating changes in coho salmon and steelhead abundance from watershed restoration: How much restoration is needed to measurably increase smolt production? North American Journal of Fisheries Management 30: 1469-1484.

check-in point to determine if all the essential elements were placed according to the design as approved by NMFS and CDFW. Based on the results of post-construction implementation monitoring, engineering techniques and approaches are revisited as deemed necessary.

Effectiveness Monitoring

Effectiveness monitoring is aimed at determining whether habitat enhancement is having the intended effect on physical habitat quality. This monitoring is designed to generate a comparison between baseline habitat quantity and quality, collected prior to any enhancement actions (pre-enhancement), post-construction habitat quantity and quality (post enhancement), and habitat quantity and quality after the first geomorphically-effective flow[51] (post-effective flow), or within three years following construction of each enhancement phase, and then at minimum every three years, to assess the long-term sustainability of all implemented habitat enhancement actions.

Validation Monitoring

Validation monitoring is aimed at determining whether habitat enhancement work is achieving the intended objectives for juvenile life stages of listed salmonids.

Frequency of Effectiveness Monitoring

The AMP recommended site monitoring at three different time periods: prior to enhancement (pre-enhancement), just after enhancement (post-enhancement), and following a geomorphically effective flow (post-effective flow). Pre-enhancement surveys include measuring depth, velocity, habitat typing, and shelter rating. Because habitat features would not yet be installed, pre-enhancement site and enhancement reach ratings do not include feature ratings. Post-enhancement surveys occur after construction and include quantitative ratings and qualitative ratings at all spatial scales (e.g., feature, habitat unit, site, and enhancement reach). The AMP also recommends collecting data after a geomorphically effective flow. In the absence of a geomorphically effective flow, the AMP recommends collecting data within three years after construction. A geomorphically effective flow in Dry Creek typically occurs within a return period of two years upstream of Pena Creek (reaches 12-15) and less than one year (i.e., annually, or sub-annually) downstream of Pena Creek (reaches 1-11). Following this, post-effective flow surveys typically occur the following spring or summer after construction. After the initial post-effective flow survey, Sonoma Water surveys each site every three years, or as outlined in the next biological opinion.

The AMP also recommends future outcomes (actions) for enhancement reaches receiving low ratings (fair to fail) that range from corrective action (repair or modification), reduction in potential habitat credit, or abandonment of features, sites, or enhancement reaches. If Sonoma Water repaired or modified a site, post-repair effectiveness monitoring is conducted shortly after repairs or modifications. Post-repair monitoring was added to the monitoring frequency categories in order to differentiate from post-enhancement monitoring that occurs immediately after site construction.

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[51] A geomorphically effective flow is the flow responsible for transporting the greatest cumulative volume of sediment in a river or stream over the long-term, estimated to be 2,500 to 3,000 cfs upstream of Pena Creek and 750 to 1,000 cfs downstream of Pena Creek (Inter-Fluve 2013 [Fish Habitat Enhancement Feasibility Study]).

Adaptive Management Plan Revisions

As part of the Proposed Action, Sonoma Water will work with the JMT, including representatives from NFMS, CDFW, and USACE, to modify portions of the AMP to reflect Sonoma Water's current methods and experience implementing it over the past 10 years. Revisions to the AMP may include simplifications to the effectiveness rating checklists to better reflect the hydrology and instream structure of Dry Creek. This may also include a recalibration of maintenance standards and triggers as well as a review of the depth and velocity metrics used to develop habitat ratings. This review process will also ensure that there is consistency between Sonoma Water's AMP and USACE's MAMP regarding future adaptive management actions.

3.8 Monitoring and Adaptive Management in the Russian River Watershed

Monitoring actions included as part of the Proposed Action are discussed below and shown within **Table 3-9**. Many of these monitoring actions are continuations with/and without modification of previous programs borne out of the RPA for the *2008 Biological Opinion*.

The results and status of monitoring conducted as part of the RPA are discussed throughout this document but are summarized within Table 4-32 in the Environmental Baseline. Table 4-32 also includes section references to the relevant discussions summarizing results of those monitoring actions, including whether the original objective of the RPA has been satisfied.

3.8.1 Reservoir and Water Supply Operations Adaptive Management

Future reservoir and river flow management actions (e.g., application of FIRO and the interim change petitions, and the Fish Flow Project) will influence water quality and salmonid migration in the mainstem Russian River and Dry Creek. Because reservoir and river flow management actions will change or be refined under the Proposed Action, monitoring should adapt to these changes. Sonoma Water has received multiple TUCOs from the SWRCB to respond to drought conditions in the watershed. The TUCOs included terms and conditions for fish, habitat, and water quality monitoring. Some of these monitoring terms may be applicable to a longer-term reservoir and water supply operations monitoring plan. However, because the interim change petitions have not been issued, no monitoring actions related to the interim change or Fish Flow Project are proposed at this time. Once issued, Sonoma Water will comply with any monitoring actions described in the TUCOs for the interim change petition and for permanent changes under the Fish Flow Project. In the interim, Sonoma Water proposes to develop an adaptive plan to monitor fish passage and water quality in conjunction with NMFS, CDFW, USACE, and the NCRWQCB. The monitoring program outlined in the adaptive management plan will include the following actions, however, the timing, duration, locations, and/or methodologies may be modified by Sonoma Water in consultation with NMFS, CDFW, USACE, and the NCRWQCB.

TABLE 3-9
PROPOSED MONITORING OBJECTIVES, METHODS, LOCATIONS, TAKE AUTHORIZATION, AND RECOMMENDATIONS

Project Element	Primary Target Species, Life Stage, Habitat	Objectives	Method	Locations[1]	Current Program	Take Authorization Required	Responsible Organization	Comments / Action
Reservoir Operations	Chinook Salmon adults	adult return estimations	video	Russian River (Mirabel Dam)	2008 Biological Opinion	no	Sonoma Water	Continue with inclusion of PIT antenna arrays.
		validation and distribution	spawner survey	Dry Creek	Sonoma Water/TUCO	yes	Sonoma Water	
		access to spawning habitat	spawner/riffle crest survey	upper mainstem	TUCO	yes	Sonoma Water	Develop monitoring plan based on flow conditions
	Salmonid smolts	abundance and survival	PIT antenna	Dry Creek	Sonoma Water	no	Sonoma Water, USACE	Develop study plan to document salmonid smolt survival.
		migration survival	acoustic telemetry	Russian River & Estuary	Sonoma Water, USACE	yes	Sonoma Water, USACE	
	Salmonid habitat conditions	Water quality	Grab sample, sondes	upper mainstem and east fork Russian River	TUCO	no	Sonoma Water	Designed to understand the relationship between reservoir storage, habitat related water quality, and water quality of reservoir releases Lake Mendocino vertical profiles are collected by Sonoma Water and Lake Sonoma profiles by USACE.
			Vertical profiles	Lake Mendocino/Lake Sonoma	TUCO	no	Sonoma Water, USACE	
Estuary Management	steelhead juveniles, Coho Salmon smolts and possibly Chinook Salmon smolts in some years	Source of PIT tagged fish for future Estuary habitat enhancement monitoring.	DSMT	Dry Creek, Russian River (Mirabel Dam), lower river tributaries defined as downstream of Mirabel Dam	2008 Biological Opinion	yes	Sonoma Water	
		Habitat use for future habitat enhancement monitoring	PIT antenna	Estuary	none	no	Sonoma Water	May include habitat use by Coho Salmon and Chinook Salmon smolts in some years.
	Salmonid habitat conditions	water quality	sondes	Estuary	2008 Biological Opinion	no	Sonoma Water	Routine sampling used in estuary management decisions; may include targeted monitoring for new habitat projects.
		physical process	camera, topographic surveys	river mouth	2008 Biological Opinion	no	Sonoma Water	Routine sampling used in estuary management decisions.
Dry Creek Habitat Enhancements	Coho Salmon and steelhead juveniles	implementation	see AMP checklists	Dry Creek	2008 Biological Opinion	no	Sonoma Water	Include maintenance/repair and any new sites; update to add annual visual site evaluation (drone, checklists) for completed sites.
		Effectiveness (1°): velocity, depth, shelter value, pool/riffle ratio	habitat mapping	Dry Creek	2008 Biological Opinion	no	Sonoma Water	Update 2014 AMP (revise checklists) and continue based on annual work plans; adjust rotating panel.
		Effectiveness (2°): water quality	water quality	Dry Creek	2008 Biological Opinion	no	Sonoma Water	Continue to follow 2014 AMP to monitor as needed.
		Validation (1°): habitat use	PIT antenna, snorkel	Dry Creek	2008 Biological Opinion	yes	Sonoma Water	Snorkeling not possible at some sites; propose defining frequency and duration of monitoring.
		Validation (1°): abundance/density	electrofish, seine	Dry Creek	2008 Biological Opinion	yes	Sonoma Water	Propose changing to secondary metric and recommend developing guidance for frequency, locations (based on conditions), and number of years to monitor.
		Validation (1°): relative abundance	DSMT	Dry Creek	2008 Biological Opinion	yes	Sonoma Water	Chinook smolt estimate; cannot accomplish steelhead or Coho smolt estimate with DSMT alone, will explore estimates using PIT antennas.
		Validation (2°): fidelity, growth/size, survival	PIT antenna, electrofish, seine	Dry Creek	2008 Biological Opinion	yes (see primary metrics)	Sonoma Water	Continue to follow 2014 AMP to monitor as needed.
Hatchery Management	Coho Salmon (all life stages)	genetic monitoring	various	Warm Springs Hatchery	Coho HGMP	no (Program covered separately)	USACE	Conduct genetic evaluation as outlined within the Coho HGMP.
	Coho Salmon juveniles, smolts, adults	effectiveness and performance of population once fish are released into the wild	DSMT, snorkel surveys, PIT antennas, spawner surveys	Mill, Green Valley, Dutch Bill, Willow Creeks	Coho HGMP		USACE	Continue to follow CSG monitoring plan.
	Coho Salmon adults	adult abundance	PIT antenna	Duncans Mills	Coho HGMP		USACE, Sonoma Water	Continue to follow CSG monitoring plan.
	Steelhead (all lifestages)	genetic monitoring	various	Warm Springs Hatchery	Steelhead HGMP	no (Program covered separately)	USACE	Conduct genetic evaluation and monitoring as outlined within the steelhead HGMP.
	Steelhead juvenile, smolts, and adults	effectiveness and performance of population once fish are released into the wild	DSMT, snorkel surveys, PIT antennas, spawner surveys	Dry Creek, Austin Creek, Green Valley Creek, Mark West Creek, Maacam Creek, and the Upper Russian River	Steelhead HGMP		USACE	

TABLE 3-9
PROPOSED MONITORING OBJECTIVES, METHODS, LOCATIONS, TAKE AUTHORIZATION, AND RECOMMENDATIONS

Project Element	Primary Target Species, Life Stage, Habitat	Objectives	Method	Locations[1]	Current Program	Take Authorization Required	Responsible Organization	Comments / Action
Annual Monitoring of Salmonid Migration in the Russian River at Mirabel/Wohler and Dry Creek	Coho and Chinook Salmon and steelhead juveniles	juvenile outmigration	DSMT	Dry Creek	2008 Biological Opinion	yes	Sonoma Water	Continue with inclusion of PIT antenna arrays.
	Chinook Salmon adults	adult return estimation	video	Russian River (Mirabel Dam)	2008 Biological Opinion	no	Sonoma Water	Continue with inclusion of PIT antenna arrays.

[1] Upper and lower mainstem refers to Russian River mainstem upstream of Dry Creek confluence.

3.8.2 Estuary Management and Habitat Enhancement

3.8.2.1 Physical and Water Quality Monitoring

Sonoma Water recommends that water quality monitoring from continuous recording sensors and operation of the remote camera at the river mouth continue as they provide valuable information related to beach management decisions. Sonoma Water also recommends that beach topographic surveys continue as needed to help inform beach management decisions. Water quality monitoring will be conducted in the lower, middle, and upper reaches of the Russian River Estuary, including two tributaries and the Maximum Backwater Area (MBA),[52] between the mouth of the river at Jenner and Vacation Beach near Guerneville. Water quality will be monitored using YSI Series 6600 multi-parameter datasondes, or similar instruments, and collect hourly salinity (parts per thousand), water temperature (degrees Celsius), dissolved oxygen (percent saturation), dissolved oxygen (milligrams per liter), and pH (hydrogen ion) data will be collected from May 15 to October 15. Current water quality monitoring stations are shown in Figure 4-13.

3.8.2.2 Biological Monitoring

Because the questions established in RPA 2 (see Section 3.4, *Estuary Management*) that necessitated seining, invertebrate sampling, and salmonid prey analysis in the Estuary have been addressed (see Section 4.3.7.10 and references therein), Sonoma Water recommends discontinuing these activities in the form they have been occurring for the *2008 Biological Opinion*. Instead, future monitoring should focus on the biological and physical processes associated with beach management and responses to habitat enhancement opportunities, which may include fish, water quality, and habitat monitoring focused on potential enhancement areas. Monitoring may also be undertaken that includes understanding the effects of estuary management on FESA- or CESA-listed non-salmonid fish species (e.g., longfin smelt). Sonoma Water will continue to monitor juvenile outmigration past the Mirabel Dam and from three tributaries downstream of the Mirabel Dam. Historically, the purpose of this effort has been to inform the timing of downstream movements into the Estuary, relative abundance, and the size and age structure of steelhead YOY by providing a source of PIT-tagged individuals that could be detected at the Duncans Mills PIT antenna array should they move into the Estuary. Sonoma Water recommends continuing these studies but modifying the objectives to focus on Coho Salmon adult and smolt abundance, migration timing, and survival (see **Table 3-10** and Section 3.8.5, *Annual Monitoring of Salmonid Migration*).

Sonoma Water will develop an adaptive management and monitoring plan outlining specific monitoring activities as part of the Proposed Action.

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[52] The maximum backwater area encompasses the area of the river between Duncans Mills and Vacation Beach that is generally outside the influence of saline water, but within the upper extent of inundation and backwatering that can occur during tidal cycles and lagoon formation.

TABLE 3-10
STREAMS AND SITES OF SONOMA WATER DOWNSTREAM MIGRANT TRAP OPERATION, AND DISTANCE OF THE TRAP SITE FROM THE MOUTH OF EACH STREAM

Stream	Site	River Kilometer	Future Monitoring Objectives
Russian River	Mirabel Dam	39.6	Coho Salmon outmigrant characterization; Chinook Salmon smolt estimates in some years
Mark West Creek	Trenton-Healdsburg Road	4.7	Coho Salmon life cycle monitoring
Dutch Bill Creek	Monte Rio Park	0.3	Coho Salmon life cycle monitoring
Austin Creek	Gravel Mine	1.1	relative abundance of Coho Salmon smolts

3.8.3 Dry Creek Habitat Enhancement

Continued monitoring for the Dry Creek Habitat Enhancement Project will be important to evaluate the performance of habitat enhancements as they mature and experience a variety of flow conditions. Sonoma Water recommends that a visual inspection of each project site is conducted annually. Habitat and geomorphic data should continue to be collected per the schedule and methodology described in the 2014 Dry Creek AMP and USACE’s MAMP until an update of the AMP is completed. Sonoma Water proposes that the Dry Creek AMP be revised to focus on parameters identified to best relate to habitat goals including revising the checklists, redefining validation performance measures, and defining frequency and duration of effectiveness and validation monitoring.[53] Post-construction monitoring actions related to the Dry Creek Enhancement Project are described under Section 3.7.8, *Post Construction.*

3.8.4 Hatchery Management

3.8.4.1 Coho Salmon Broodstock Program Monitoring and Genetic Analysis

Data has shown that the way in which genetics have been managed for the Coho Salmon Broodstock Program, which is being covered under separate FESA processes, have had a positive impact on the genetic make-up of the Russian River Coho Salmon population.[54] Further, monitoring to evaluate the effectiveness and performance of the population once fish are released into the wild has been important for guiding release strategies including life stage, season, and location. Therefore, USACE will continue these efforts as described for RPA element 4 within the *2008 Biological Opinion*. These efforts include:

- Genetic analysis as outlined in the Coho Salmon Broodstock Program Habitat Genetic Management Plan (HGMP) will be conducted annually for all Coho Salmon in the program, and the results of the analyses (genetic matrix) will be used to dictate the combinations of mature Coho Salmon to use in the spawning process.

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[53] Porter, M., D. Marmorek, D. Pickard, and K. Wieckowski, 2014. *Op. cit.*

[54] CDFW & USACE, 2017. Don Clausen Fish Hatchery: Russian River Coho Salmon Captive Broodstock Program. Hatchery Genetic Management Plan. Prepared for National Marine Fisheries Service. September 2017.

- Genetic assessments of both the naturally-spawning and hatchery-reared components will be conducted over time, to determine the loss or increase of genetic variation in each component.
- Monitoring and evaluation of the Broodstock Program will be conducted to evaluate the effectiveness and performance of program. This will include monitoring of juvenile and adult Coho Salmon in multiple release streams to assess survival of the juveniles released, adult returns, spawning success, and to determine if there is an increase in abundance of natural production of Coho Salmon in these streams.
- The Broodstock Program will be adaptively managed based on information gathered from the monitoring and evaluation component.

3.8.4.2 Steelhead Integrated Harvest Hatchery Program

Monitoring actions prescribed in the steelhead HGMP are also covered under separate FESA process but are described here because of their relation to other monitoring actions proposed by Sonoma Water in the Russian River. Many of the actions outlined below are consistent with 2008 Biological Opinion RPA/RPM measures for steelhead monitoring and genetic analysis. Monitoring efforts described in the steelhead HGMP include:

- Genetic analysis as outlined in the Steelhead Integrated Harvest Hatchery Habitat Genetic Management Plan (HGMP) will be conducted annually for all steelhead in the program, and the results of the analyses (genetic matrix) will be used to dictate the combinations of mature steelhead to use in the spawning process.[55]
- Genetic assessments of both the naturally-spawning and hatchery-reared components will be conducted over time, to determine the loss or increase of genetic variation in each component.
- Monitoring and evaluation of the steelhead program will be conducted to evaluate the effectiveness and performance of program. This will include monitoring of juvenile and adult steelhead in multiple release streams to assess survival of the juveniles released, adult returns, spawning success, and to determine if there is an increase in abundance of natural production of steelhead in these streams.
- Evidence of hatchery-origin steelhead predation on juvenile Chinook Salmon, Coho Salmon and steelhead will be collected by sampling the stomachs of juvenile hatchery steelhead in the mainstem Russian River and Dry Creek watersheds.
- To obtain accurate estimates of steelhead harvest rates, and harvest effects to natural steelhead populations, a creel survey would need to be implemented in the Russian River for three consecutive years. The results of these surveys will be compared to available Steelhead Report Card information to determine the accuracy of the Steelhead Report Card estimates of the harvest rate and origin of fish (hatchery and natural) caught as well as released.

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[55] CDFW & USACE, 2021. Russian River Steelhead Integrated Harvest Hatchery Program. Hatchery Genetic Management Plan. Prepared for National Marine Fisheries Service. July 2021.

3.8.5 Annual Monitoring of Salmonid Migration

Sonoma Water will continue to monitor fish passage at the Wohler-Mirabel facilities with a downstream migrant trap for juvenile salmonid monitoring and video monitoring inside the fish ladder for adult salmonids. Monitoring will also include stationary PIT antenna arrays to facilitate life cycle monitoring and survival analysis. Monitoring will continue in Dry Creek with a downstream migrant trap, stationary PIT antenna arrays, and late-summer surveys to assess AMP validation metrics for Coho Salmon and steelhead including habitat use as well as survival, fidelity, and growth when possible.

Coho Salmon smolt migration mortality is an important knowledge gap; and identifying threats to survival are key to informing species recovery. Sonoma Water, USACE, and California Sea Grant (CSG) have begun gathering information on Coho survival and travel time during their seaward migration. Detections of PIT-tagged Coho smolts have provided information regarding travel time from tributary of origin (or release) and Estuary entry. Initial studies suggest that acoustic telemetry can help answer similar questions at a finer scale along the same migration corridor, including the Russian River Estuary. Migration studies based on PIT- and acoustic-tagging will further inform Coho Salmon Broodstock Program release strategies while providing the broader context necessary for accurately evaluating results from other life cycle and abundance monitoring efforts. Sonoma Water and USACE will develop a monitoring plan in coordination with NMFS and CDFW designed to address the smolt migration mortality knowledge gap. (See proposed Special Study Conservation Measure under Section 6.8).

3.9 Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consultation. Sonoma Water's water diversion and transmission system is considered to be interdependent of water releases at CVD and WSD.

3.9.1 Water Diversion Operations

Sonoma Water delivers water to its customers through its water transmission system, which has a peak monthly average production demand of 42.9 million gallons per day (mgd) (2018 through 2022), and a capacity of up to 92 mgd. The diversion and treatment facilities are located adjacent to the Russian River in the vicinity of Forestville at Mirabel (an area near the former Mirabel resort) and Wohler (a site near Wohler Road). The transmission system, which includes radial collector wells, disinfection and corrosion control (pH adjustment) facilities, pipelines, storage tanks, pumps, and conventional wells, conveys water from the diversion facilities on the Russian River to service areas in Sonoma County and northern Marin County.

3.9.1.1 Diversion Facilities

Sonoma Water's diversion facilities along the Russian River include an inflatable dam, the Mirabel diversion facility (comprised of three radial collector wells and the Russian River well field), a screened surface water intake and infiltration ponds, and the Wohler diversion facility (comprised of three radial collector wells) (**Figure 3-4**). The Mirabel Dam system was originally constructed in 1974/75 as part of the Russian River to Cotati Intertie Project. The inflatable dam fabric has subsequently been replaced twice.

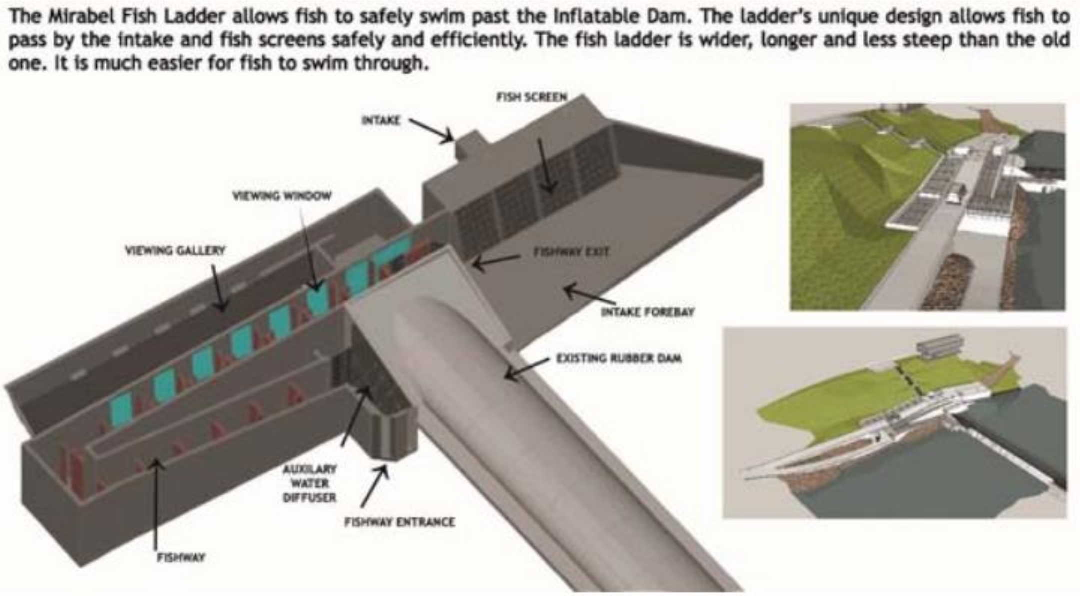
The Mirabel Fish Ladder allows fish to safely swim past the Inflatable Dam. The ladder's unique design allows fish to pass by the intake and fish screens safely and efficiently. The fish ladder is wider, longer and less steep than the old one. It is much easier for fish to swim through.

Figure 3-4
Mirabel Fish Ladder and Diversion Facility

The ability of the Russian River alluvial aquifer to produce water is generally limited by the rate of recharge to the aquifer through the streambed in the vicinity of the Mirabel and Wohler diversion facilities. To augment this rate of recharge, Sonoma Water has constructed four infiltration ponds and a water-filled inflatable dam located on the Russian River just upstream of the Mirabel area. When the dam is inflated, it raises the water level and submerges the intakes to three diversion pumps. The water is pumped through pipes in the levee adjacent to the river into a sedimentation pond that outlets to a lined channel, which conveys water to four Mirabel infiltration ponds encompassing a total area of approximately 40 acres. The inflatable dam also creates a backwater pool which increases the water level in the vicinity of the Wohler collectors. This increase in water level increases the rate of recharge from the river to the alluvial aquifer adjacent to and beneath the Wohler collector wells.

Inflatable Dam

The inflatable dam is a critical component of Sonoma Water's water supply system. It is inflated to create a pool (referred to as the Wohler Pool) upstream of the dam during low flow periods. During higher flows, the dam is deflated and lays flat on the river bottom. The Wohler Pool increases the amount of recharge into the aquifer underneath and adjacent to the Russian River. In addition, the Wohler Pool inundates an intake structure on the west side of the Mirabel Dam which is utilized to divert water from the Russian River into a series of infiltration ponds west of the Russian River.[56] These infiltration ponds (43 acres combined) are used to recharge the aquifer under the Russian River. The recharge of the aquifer either directly from the Wohler Pool or from the infiltration ponds is critical in Sonoma Water being able to operate its water supply system.

The inflatable dam at Mirabel is a fabricated rubberized material[57] and is attached to a concrete foundation in the riverbed. When inflated, the dam is 11-feet-high and spans the width of the entire river. The inflatable dam is usually raised in late spring when water demands increase and the Russian River stream flow drops below 2,000 cfs. Stream flow may spill over the dam until the dam is fully inflated, at which point most of the flow passes through the fish ladder and associated bypass structure. The dam will be operating for about seven months each year, on average. The dam will be lowered in the fall or early winter when stream flow approaches 1,600 cfs. When the dam is deflated, it does not impede migration or create a backwater. Under current protocols, inflation of the dam takes approximately 3-10 days to complete, whereas deflation takes 1-5 days. Given that the dam is 11 feet high, stage-change in the river upstream of the dam is approximately 0.10 feet per hour (ft/hr) during inflation (depending on river flow) and 0.20 ft/hr during deflation (depending on river flow).

Fish Screens

The Mirabel diversion facility is located on the west side of the river adjacent to the inflatable dam. Water that is diverted from the river through a screened surface water intake and pumped into infiltration ponds. The *2008 Biological Opinion* found that the fish screen had the potential to trap young, endangered Coho Salmon and threatened steelhead. Specifically, RPM 6 required Sonoma Water to “complete design of a new fish screen at Mirabel within three years of the issuance of this biological opinion and replace the fish screen within three years after completion of the design” (p. xix). In 2009, Sonoma Water began developing plans to replace the fish screen.

In 2014 Sonoma Water began construction to replace the rotary drum fish screens at Mirabel to meet NMFS criteria for screen openings. The original drum fish screens were replaced by six 12-foot-tall by 6-foot-wide panels, with a total area of 432 square feet. The new fish screens incorporate an electric motor-driven mechanical brush system that periodically moves back and forth to clean the intake screen structure.[58] After flowing through a sedimentation pond adjacent to the diversion caisson, diverted water enters a small open channel, which distributes water to the four infiltration ponds through manually operated slide gates. Construction of the fish screen was completed in 2016.

Fish Ladder

While the original Denil style fish ladders worked, they were not ideal for juvenile salmonids migrating downstream. In addition to replacing the fish screens as described above, the Mirabel Fish Screen and Ladder Replacement Project included construction of a new vertical slot fishway

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[56] The Wohler Pool extends approximately 4.75 kilometers upstream, with an average wetted width of approximately 150 feet, when the inflatable dam is raised.

[57] The fabric for the inflatable dam was replaced in 1995 and in 2021.

[58] NMFS, 2014. Mirabel Fish Screen/Ladder Project Biological Opinion. USACE and Sonoma County Water Agency. WCR-2013-9815. June 16, 2014.

on the west side of the inflatable dam and facility improvements to address seismic vulnerabilities.

To replace the existing west bank fish ladder, a vertical slot fish ladder was selected as the best option to provide passage to upstream migrating salmonids.[59] The new fish ladder extends approximately 100 feet further downstream than the original fish ladder. The new ladder consists of a sloped, reinforced concrete rectangular channel separated by vertical baffles with 15-inch - wide slots that extend down the entire depth of the baffle. The baffles are located at even increments to create a step-like arrangement of resting pools. The fish ladder is self-regulating, providing a consistent velocity, flow depth, and water surface differential at each slot over a range of operating conditions. The ladder is configured to accommodate fish passage while the Mirabel Dam is inflated and river flows range from 125 to 800 cfs. While not the primary focus of the design, fish passage is also provided while the Mirabel Dam is deflated. Monitoring data showed that fish passage when the Mirabel Dam was inflated was primarily through the new vertical slot fish ladder on the west bank. Therefore, with the approval of NMFS and CDFW, the remaining Denil fishway on the east bank of the river was decommissioned in 2021 by being filled with gravel and sealed with a concrete cap.

Monitoring Components and Viewing Chamber

Sonoma Water currently conducts a variety of fisheries monitoring activities at its Mirabel Dam facilities. The fish ladder supports these monitoring activities by providing a dedicated viewing window and video equipment room. The monitoring information collected by Sonoma Water is critical in tracking population trends and species movement in the watershed. The continuation of this monitoring is included as part of the Proposed Project (see Section 3.8, *Monitoring and Adaptive Management in the Russian River watershed*).

The fish ladder facility also includes a viewing area, separate from the video monitoring viewing window, which allows visitors to see into the side of the fish ladder. At a river elevation of 41 feet, the top of the viewing gallery is inundated. At this elevation, fish in the river could enter into the viewing gallery area from the top and become stranded. River flow elevations typically exceed 41 feet in elevation 4 to 5 times a season (remaining above 41 feet 2 to 10 days at a time). As elevations recede below elevation 41 feet, fish that remain in the viewing gallery would be able to passively leave the viewing chamber through the 12-inch drain pipe connected to the alternative water supply pipe. After sustained river surface elevation drops below 35 feet, the valve for the 12-inch drain pipe in the floor sump of the viewing gallery would be closed. Sonoma Water fisheries biologists would then rescue any remaining fish from the viewing gallery area (first by seine, followed possibly by electrofishing) and the remaining water in the gallery would be pumped-out into the Mirabel infiltration basin. Sonoma Water anticipates that one rescue operation per year would be required; however, depending upon the timing of inundation events, additional rescue efforts may be necessary each season.

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[59] SCWA, 2012. Mirabel Fish Ladder and Fish Screen Replacement Project. ISMND. November 21, 2012.

Collector Wells

To provide the primary water supply for the water transmission system, Sonoma Water operates six radial horizontal collector wells and seven vertical wells adjacent to the Russian River near Wohler Road and Mirabel, which extract water from the alluvial aquifer beneath, and adjacent to, the streambed. Each collector well consists of a 13- to 18-foot-diameter concrete caisson that extends 60 to 110 feet deep into the alluvial aquifer. Perforated horizontal intake pipes extend radially from the bottom of each caisson to a maximum of 350 feet into the aquifer. Each collector well houses two vertical turbine pumps that are driven by 1,000 to 2,000 horsepower (hp) electrical motors. Pumps at Wohler are rated to deliver up to 10 to 21 mgd, and at Mirabel each pump is rated to deliver up to 13 mgd.

Vertical Wells

Seven vertical wells, collectively referred to as the Russian River Well Field, are located in the Mirabel area. These wells draw water from the aquifer adjacent to the Russian River. The wells provide up to 7 mgd of emergency production capacity.

Since the construction of the 54-inch Wohler-Forestville Pipeline, the Mirabel and Wohler collector wells are interconnected. Water may be sent to the Cotati Intertie or the Santa Rosa Aqueduct from either the Mirabel or Wohler facilities, depending on the relative activity of pumping at each facility. The water transmission system also includes three groundwater wells located along the Russian River-Cotati Intertie pipeline at Occidental Road, Sebastopol Road (Highway 12), and Todd Road.

3.9.1.2 Treatment Facilities

Filtration

Water is diverted from the Russian River after it is filtered through the alluvial aquifer below and adjacent to the streambed and infiltration ponds, and thus requires no further treatment other than disinfection and pH adjustment.

Water Chemistry

Sonoma Water operates pH adjustment/corrosion control facilities to limit lead and copper content in drinking water. These facilities are located at the Sonoma Water Wohler maintenance yard and the River Road chlorination facility. The water is treated with caustic soda to raise the pH of pumped Russian River water. Although the water produced by the existing collector wells contains no detectable levels of lead and copper, the water is naturally moderately corrosive and can leach lead and copper from indoor plumbing and water fixtures. The caustic soda for water treatment is stored in two 10,000-gallon containers (at Wohler corrosion control facility and two 10,000-gallon at the River Road facility). The pH control buildings are located about 200 yards from either the Russian River or Mark West Creek; however, the concrete masonry walls of the pH control buildings are designed to provide secondary containment to prevent the caustic soda from contaminating a large area if leaks occur within the pH control buildings.

Sonoma Water currently disinfects the water produced at the well facilities with chlorine. Chlorine gas is mixed with water inside three chlorine facilities to form a concentrated chlorine and water solution. This chlorine and water solution is transported through underground pipes to each collector well and is injected into the caissons to disinfect the water. The buildings used to store chlorine are equipped with leak detection alarm systems that send a signal to the operations and maintenance center indicating any leak locations. Additionally, scrubbers would be activated if chlorine gas is accidentally released. At the Occidental, Sebastopol Road and Todd Road wells, Tri-chlor is used on-site to generate an aqueous chlorine solution.

3.9.1.3 Transmission System

Currently, Sonoma Water’s water transmission system has 142 km of 16 to 54-inch diameter pipe in place to distribute water from the diversion facilities to water users in Sonoma and Marin counties. Sonoma Water has 18 storage tanks in southern Sonoma County with 129.6-million-gallon total storage capacity. Presence of the pipelines or storage tanks do not likely affect FESA listed salmonid species or critical habitat, though unplanned releases from the transmission system may affect FESA-listed salmonid species or critical habitat. The pipelines contain approximately 17 air relief valves, which may potentially discharge potable water to various creeks and drainage swales or ditches. These valves were installed to protect pipelines by relieving the pressure surges created when an abrupt change in flow occurs (and overflow lines from tanks). The maximum residual chlorine concentration in these discharges is approximately 1.00.6 ppm. To reduce the likelihood of corrosion on some pipelines, Sonoma Water has buried magnesium alloy anodes at regular intervals (typically every 20 to 40 to 40 feet) that will sacrificially corrode instead of the steel pipeline. In other sections of pipelines, Sonoma Water induces a small electrical current. This electrical current ensures the steel of the pipeline is less likely to corrode than metal alloy anodes (installed approximately 1,000-foot intervals).

3.9.1.4 Maintenance Activities

Maintenance of Levees, Access Roads, and Infiltration Ponds

Routine maintenance of levees, access roads, and infiltration ponds at Mirabel and Wohler will likely have a negligible effect on FESA-listed species or critical habitat (See Section 3.4.2, *Channel Maintenance* for a discussion of herbicide application procedures). Maintenance of these areas involves removing vegetation with the use of herbicides as described above and mowing of vegetation along levee roads. Vegetation maintenance does not occur on streambanks near the river but does occur along roads that are 200 to 250 feet from the Russian River and provide access to the Mirabel area.

Inflatable Dam Maintenance

Each time the inflatable dam is lowered, the fish screens at Mirabel are removed so they are not damaged during high-water events. Raising the inflatable dam sometimes requires removing sediment that has accumulated during the winter on the flattened dam fabric and within the fish ladders. The accumulated sediment is removed typically with an excavator working only in areas isolated from the flow of the Russian River to prevent turbid water from reaching the river channel. Spoils are then stored out of the flood plain or hauled away.

Groundwater Wells Maintenance

Operation of Sonoma Water's Occidental Road, Sebastopol Road, and Todd Road wells can require discharging well water for sampling or flushing purposes. However, these discharges usually involve unchlorinated water and are conducted infrequently. The water at the Occidental well discharges into City of Santa Rosa's reclamation line, the Todd Road well discharge water goes into an on-site storage tank and then is trucked to City of Santa Rosa's Llano Road wastewater treatment plant, and the Sebastopol Road well water is discharged into City of Santa Rosa's reclamation line. As such these activities should have no effect on salmonids, and therefore, these releases are not discussed further.

Water Storage Tanks Maintenance

Maintenance of the water storage tanks includes periodic inspection, cleaning, recoating of the interior and exterior tank surfaces, structural repairs, and regulatory and safety upgrades which may require that the tanks be emptied. To the extent possible, the water in the tanks is drained into the water transmission system. The small amount of water remaining in the storage tanks after draining into the water transmission system is dechlorinated with sodium sulfite tablets to eliminate any chlorine residual and drained to the ground in accordance with the approved Non-Storm Water Discharge Best Management Plan. These controlled discharges occur approximately once every five years as part of maintenance activities. Overflow pipelines in each water storage tank are necessary to provide an emergency release route if water levels in the tank should rise too high. While automated control valves in the water transmission system have been installed to prevent this, overflow of chlorinated water may occur under certain unforeseen circumstances.

Equipment and Building Maintenance

Routine maintenance of equipment and buildings will occur outside of the active channels. All facilities used to store hazardous materials are designed, manufactured, and constructed in accordance with the Uniform Fire Code, the Uniform Building Code, and applicable local codes and ordinances.

Gravel Bar Grading in the Mirabel/Wohler Diversion Area

Gravel bar grading will continue to be conducted in the Russian River near the Mirabel/Wohler diversion areas as needed to support inflation of the dam. Importantly, gravel bar grading is no longer conducted to increase infiltration capacity. Grading and removal of gravel would only be required after large depositional events following high flow periods. Gravel removal would only occur in areas that are not inundated by the active flow of the Russian River or in areas that can be isolated from the active flow of the Russian River. Similarly, all equipment would remain outside the wetted channel. Material would be removed by excavator and placed in a dump vehicle to be hauled via access road to an upland location within Sonoma Water's Mirabel Property. Upon completion of gravel removal, the gravel bar area will be groomed to remove any tire ruts. The gravel removal area and the gravel bar would be inundated by the backwater created by raising the inflatable dam. Additionally, maintenance occasionally requires removal of gravels from on top of and adjacent (both upstream and downstream) to the dam as necessary to maintain the dam operations. Additionally, the following BMPs would be implemented during any gravel removal activities:

- Isolate the work area from active river flow: In most cases, Sonoma Water staff will limit the work area to locations that are currently dry and isolated from the Russian River. If necessary, Sonoma Water staff would isolate the work area from the active river flow either by utilizing temporary sandbags, or the natural barrier of the existing gravel bar.
- Fish rescue: If work is limited to dry locations no fish rescue efforts will be required. Any fish in areas isolated from the river within the work area will be rescued and returned to a suitable location in the river outside of the work area.
- Turbid water: No work would occur within the active flow of the Russian River. Sonoma Water staff would monitor work and either isolate as necessary or stop work if activities result in turbid water leaving the work area and entering the Russian River.
- Equipment fueling and leaks: All equipment will be inspected to ensure it is in proper operational condition with no leaks of fuel or oil. All equipment will be removed back to the service road prior to any refueling.
- Work area rehabilitation: Upon completion of the gravel removal, erosion control wattles (with no plastic netting or strings) will be installed along the sloped portion of the access road level with the elevation line. This area will also be seeded with a native seed mix and mulched. Willow cuttings will be installed along the bank area of the access road.

3.9.1.5 Wastewater Treatment

Project operations for purposes of water supply result in the diversion of up to approximately 65,000 acre-feet of water from the Russian River. A substantial portion of this water supply is consumed, eliminated as waste, treated as wastewater, and ultimately either recycled or discharged back into the Russian River watershed or San Pablo Bay as treated effluent. Several wastewater treatment plants (WWTPs) serve Sonoma Water’s primary and secondary water contractors, including contractors who divert water under Sonoma Water’s water rights.

Wastewater discharges are controlled and scheduled under the established policies of the Water Quality Control Plan for the North Coast.[60] Water treated to a tertiary level is discharged back into the Russian River, Jones Creek, Dutch Bill Creek, Mark West Creek, and the Laguna de Santa Rosa tributaries of the Russian River. None of the facilities discharge to tributaries of the Russian River between May 15 and October 1; some commence discharges beginning in November, some end discharges by April 30. Under the permits issued by the NCRWQCB, the identified WWTPs can only discharge at 1% of the current flow rate, with the exception of the Santa Rosa Subregional Wastewater Reclamation System (SRSWRS), which has a discharge allowance of 5% of ambient flow.

3.10 Conservation Measures

The following conservation measures have been included as part of the Proposed Action to avoid and minimize potential adverse effects to listed fish species, and to address uncertainties associated with the current status of species and habitat conditions in the watershed. Conservation

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[60] North Coast Regional Water Quality Control Board, 2018. Water Quality Control Plan for the North Coast Region. Santa Rosa, CA. June 2018.

measures CM1 through CM4 are voluntary measures developed to avoid and minimize potential adverse effects associated with non-discretionary federal actions (see discussion in Section 3.2, *Reservoir Operations*, above).

The conservation measures do not include a number of compulsory measures (e.g., standard BMPs, in-water work windows, etc. associated with channel maintenance and Dry Creek enhancement construction activities) that are required to comply with regulatory permits and are included as part of the Proposed Action, as described above for different project elements. Further, they do not include ongoing monitoring and adaptive management activities, which are also included as part of the Proposed Action, and described above for different project elements (e.g., estuary management, Dry Creek habitat enhancements, monitoring and adaptive management of salmonids in the watershed, monitoring conditions originating from TUCO conditions).

CM1: Flood Control Operations Ramping Rates for Coyote Valley Dam: Flood control operations at Lake Mendocino would be conducted consistent with the ramping schedule criteria identified by NMFS and USACE,[61] except when emergency flood control actions are required. Flow releases for flood control may occasionally curtail flow releases where down ramping rates exceed 100 cubic feet per second (cfs/hr) in those circumstances where more expedient operations are required to meet operational criteria for flood control. This down ramping schedule is summarized in **Table 3-11**.

TABLE 3-11
DOWN RAMPING RATES AT CVD FOR FLOOD CONTROL OPERATIONS

Flood Release Range	Ramping Rate	Applicable Date Range
2,500 cfs and 4,000 cfs	250 cfs/hour	Prior to March 15
< 2,500 cfs	100 cfs/hour	Prior to March 15
< 250 cfs	25 cfs/hour	March 15 and May 15
< 250 cfs	25 cfs/hour	May 16 and March 14

SOURCE: NMFS, April 14, 2016. Letter from NMFS to USACE summarizing the results of studies to evaluate ramping rates downstream of Coyote Valley Dam as a component of directives stipulated in RPM-3 in the *2008 Biological Opinion* for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River Watershed.

The basis of the down ramping schedule was generated from studies conducted by USACE and NMFS designed to address RPM-3 of the *2008 Biological Opinion*. USACE and NMFS monitored fish stranding and stage height changes along eight transects in the upper Russian River between the confluence of the West and East forks of the Russian River and the Perkins Street Bridge under a series of flow releases.[62] Results from the monitoring effort suggested that higher ramp-down rates (e.g., 500 cfs/hour to 1,000

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[61] NMFS, April 14, 2016. Letter from NMFS to USACE summarizing the results of studies to evaluate ramping rates downstream of Coyote Valley Dam as a component of directives stipulated in the *2008 Biological Opinion* for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River Watershed.

[62] NMFS, 2011. A Proposed Plan for Minimizing the Effects of Flow Release ramp-downs at Coyote Valley Dam on Threatened Salmon and Steelhead in the Russian River.

cfs/hour) were likely to have adverse effects on listed salmonids. In the interest of minimizing and avoiding these effects, NMFS and USACE developed a new ramping schedule for the period when CVD is within the flood control pool (see Table 3-10; NMFS, 2016).

CM2: Dam Inspection Flow Releases for Coyote Valley Dam: Annual pre-flood inspections conducted at CVD during September, and periodic inspections occurring once every five years, would continue as non-discretionary activities. A comprehensive outlet tunnel inspection is required at-least every five years to support periodic inspection documentation. It does not need to occur coincidentally with other pre-flood/periodic inspection activities. To support a comprehensive inspection, 0 cfs outflow is required. Outlet tunnel inspections of this nature would be conducted at any time when hatchery operations are offline, and natural flows measured at the West Fork of the Russian River are in excess of 300 cfs. These inspections involve ramping down reservoir releases to zero, followed by a four-hour inspection period, after which normal operating releases are restored.

Dam inspection flow releases will be made as specified consistent with revisions to inspection ramping guidelines contained in the WCM. These included development of Exhibit E of the WCM, *Operational Requirements for Pre-Flood and Periodic Inspections and Maintenance Activities*, which addressed both RPM-2 and RPM-3 of the *2008 Biological Opinion*.[63] WCM Exhibit E contains a *Supplemental Operation Schedule for Routine Inspection and Maintenance Activities*, which includes an updated ramping schedule and specifies communications prior to and subsequent to the inspection. The updated ramping schedule now used at CVD was designed to address specific concerns regarding potential impacts during the September low flow period. WCM Exhibit E also outlines procedures for stream monitoring in the East Fork and mainstem Russian River during inspections.

Pre-flood inspections at CVD will be conducted annually and occur on one day during the month of September for the period under consultation. Periodic inspections occur once every five years. The comprehensive outlet tunnel inspections will involve ramping down flow releases from the dam to zero, followed by a two-hour inspection period with zero flow release, and then ramping up to normal operating flow (**Table 3-12**).

TABLE 3-12
RAMPING RATES AT CVD FOR MAINTENANCE AND INSPECTIONS

Ramping Rate	Applicable Period
12 cfs/hour and no more than 24 cfs/day	Maintenance and Inspection

SOURCE: NMFS, 2017. NMFS letter in response to State Water Resources Control Board Order approving petitions for temporary petitions for temporary urgency changes to permit terms and conditions.

During the zero flow release phase of the procedure, USACE will inspect the 5- by 9-foot service and emergency gates, the 720-foot long steel-lined concrete conduit, and the facility outlet works. USACE will coordinate monitoring of the stream reaches below CVD during the pre-flood inspection activities. Two-person stream survey crews will

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[63] 1986 Coyote Valley Dam Water Control Manual Exhibit E, plate E5, dated June 2011.

survey specific stream reaches below the dam and make observations related to changes in stream characteristics and fish distribution as a result of this conservation measure.

CM3: Flood Control Operations Ramping Rates for Warm Springs Dam: Flood Control Schedules (FCSs) for each reservoir specify the rate at which water can be released and were developed within the respective WCMs at the time of their publication. According to the FCSs, flow releases are conditional on previous high reservoir stages and dictate maximum flow guidelines for the river reaches downstream. Under this conservation measure, operations at Lake Sonoma and WSD would comply with the FCSs ramping schedule criteria summarized below in **Table 3-13**.[64]

TABLE 3-13
RAMPING RATES AT WSD FOR FLOOD CONTROL OPERATIONS.

Reservoir Outflow (cfs)	Down Ramping (cfs/hour)	Up Ramping (cfs/hour)
0-250	25	1,000
250-1,000	250	1,000
>1,000	1,000	2,000

SOURCE: NMFS, 2008. Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River Watershed.

CM 4: Dam Inspection Flow Releases for Warm Springs Dam: Annual pre-flood or periodic inspection of the dam structure and operating systems at WSD will be ongoing and occur during August or September. During the periodic inspection periods, USACE provides a minimum bypass flow of 25 cfs. Similarly, annual and periodic (5-year) pre-flood inspections would continue for the WSD facilities, with ramping rates as summarized in **Table 3-14**.

USACE would continue to conduct inspections of WSD during those times of the year that avoid adverse effects to juvenile and adult salmonids. Inspections have been in late August or September to allow juvenile steelhead to reach a sufficient size to avoid stranding impacts during the ramp down of flow to the minimum stream levels maintained during inspection. Ramping rates in preparation for the inspection period at WSD are also designed to minimize effects on salmonids downstream (Table 3-5).

TABLE 3-14
RAMPING RATES AT WSD FOR MAINTENANCE AND INSPECTIONS

Ramping Rate	Applicable Period
12 cfs/hour and no more than 24 cfs/day	Maintenance and Inspection

SOURCE: NMFS, 2017. NMFS letter in response to State Water Resources Control Board Order approving petitions for temporary petitions for temporary urgency changes to permit terms and conditions.

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[64] USACE, 1998. Exhibit A: Standing Instructions to the Project Operators for Water Control Warm Springs Dam, Lake Sonoma. Water Control Manual, Coyote Valley Dam Lake Mendocino. September 1998.

CM5: Coho Salmon Survival Studies: In order to address uncertainties associated with Coho Salmon smolt survival, with a particular interest on loss, including that associated with predation, Sonoma Water propose the following conservation measure (see Section 6.8 for additional context).

Sonoma Water shall undertake special studies to better understand loss rates of outmigrating salmonids and, if necessary, implement measures to ensure that harm and mortality to listed salmonids are low.

Sonoma Water and USACE will develop and implement special studies to better understand loss rates of outmigrating salmonids and, if necessary, implement measures to ensure that harm and mortality to listed salmonids are low.

- The study objective is to estimate salmonid survival from Dry Creek through the mainstem Russian River and Estuary – the "migration corridor" and to evaluate methods for characterizing sources of mortality with a focus on identifying effects associated with facility operations. Special emphasis will be placed on addressing uncertainties associated with areas with higher loss rates identified from previous studies (e.g., confluence of Dry Creek and Russian River, Syar ponds, Mirabel Dam and Wohler Pool) and species of management concern (e.g., listed salmonids, native and nonnative predatory fishes, avian predators).
- A study plan will be developed in coordination with NMFS and CDFW within one year of the issuance of the new BO and ITP. The study plan will include schedules for field implementation and reporting.
- Study methodologies may include the use of acoustic telemetry, predation detection transmitters, boat electrofishing, predation event recorders, avian predator surveys, and other techniques.
- If sources of mortality concern are attributed to Sonoma Water and/or USACE facility operations, Sonoma Water will implement contingency measures to ensure that harm and mortality to listed salmonids are minimized.

CM6: Longfin Smelt eDNA Estuary Monitoring: To address the uncertainties identified in sections 4.9.2 and 6.3.1.5, Sonoma Water proposes to develop and implement, in consultation with CDFW, an eDNA monitoring program focused on Longfin Smelt in the Estuary. Because eDNA monitoring is passive (i.e., collection of water samples for DNA extraction), it would not involve capture or handling of individuals, and therefore, there would be no effects on the species associated with this activity.

- The study objective is to determine Longfin Smelt presence and, if presence in the Estuary is detected via eDNA, estimate general seasonal and distribution patterns, to the extent possible.
- A study plan will be developed in coordination with CDFW and USFWS within one year of the issuance of the new BO and ITP. The study plan will include schedules for field implementation and reporting.
- Study methodologies may include habitat stratification and eDNA sampling informed by existing understanding of Estuary hydrology/hydrodynamics, water quality, and physical habitat dynamics.

- If Longfin Smelt eDNA is detected, this species will be further considered associated estuary management and enhancement planning activities.

SECTION 4

Environmental Baseline

The USFWS and NMFS joint consultation regulations require the ‘environmental baseline’ section to include “the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impacts of state or private actions which are contemporaneous with the consultation in process.” This definition of environmental baseline is intended to capture ongoing (“present”) effects, which would include those ongoing effects associated with operation of previously constructed facilities.

This section includes a description of environmental conditions in the Russian River watershed action area, followed by a description of USACE and Sonoma Water operations and maintenance activities that have been conducted since the publication of the *2008 Biological Opinion*.

Table 4-1 provides a summary of project elements included in the environmental baseline and status associated with past and ongoing operations and maintenance.

TABLE 4-1
SUMMARY OF PROJECT ELEMENTS INCLUDED IN THE ENVIRONMENTAL BASELINE AND STATUS

Project Element	Summary Description and Status	Relevant 2008 Biological Opinion RPAs and RPMs
Reservoir Flood Control Operations at Coyote Valley Dam (CVD) and Warm Springs Dam (WSD)	USACE has implemented operational refinements in response to the *2008 Biological Opinion* RPMs, which were designed to address streambed scour and bank erosion, down ramping rates, and turbidity to minimize reservoir flood operation impacts (primarily associated with operational requirements for pre-flood and periodic inspections and maintenance activities) on salmonids below CVD. USACE has also been implementing flood control operations associated with a *Planned Major Deviation* to the 1986 Lake Mendocino WCM (initiated in WY 2021) and application of FIRO procedures. The Deviation with application of FIRO allows for a flexible water management approach that uses data from watershed monitoring and improved weather forecasting to help reservoir operators selectively retain or release water from reservoirs for increased resilience to droughts and floods. USACE has been implementing flood control operations at WSD consistent with the Lake Sonoma WCM; future proposed modifications associated with application of FIRO procedures, are in development, but have not been implemented to date.	RPM 2: Undertake measures to ensure that harm and mortality to listed salmonids from pre-flood/periodic maintenance at CVD are low. RPM 3: Undertake measures to ensure that harm and mortality to listed salmonids from ramping procedures at CVD are low. RPM 4: Undertake measures to assist NMFS in determining the amount of take resulting from turbidity releases at CVD.

TABLE 4-1 (CONTINUED)
SUMMARY OF PROJECT ELEMENTS INCLUDED IN THE ENVIRONMENTAL BASELINE AND STATUS

Project Element	Summary Description and Status	Relevant 2008 Biological Opinion RPAs and RPMs
Reservoir Water Supply Operations at CVD and WSD	Sonoma Water has annually filed TUCPs with the SWRCB in order to implement the *2008 Biological Opinion*'s RPA and/or in response to prevailing Lake Mendocino storage conditions. After review and approval of these petitions the SWRCB then issues Temporary Urgency Change Orders (TUCOs). Sonoma Water filed a Notice of Preparation (NOP) for the Fish Habitat Flows and Water Rights Project EIR in September 2010 and filed petitions with the SWRCB to permanently change its water rights. Sonoma Water also published a Draft EIR for the project in August 2016. Specific Fish Flow Project flow schedules and associated indices are subject to future revision based on ongoing discussions between Sonoma Water, USACE, and resource agencies, including NMFS, and may be modified through preparation of the recirculated Draft EIR in response to public and resource agency comments received on the Draft EIR, and revisions based on development of modeling scenarios that reflect reasonably foreseeable likely future PVP operations.	RPA Modification: Pursue Changes to Decision 1610 Flows
Russian River Estuary Management	Sonoma Water has been implementing requirements in the *2008 Biological Opinion*, which called for a series of incremental steps to adaptively manage the Estuary as new information is obtained. In addition to required monitoring, a series of studies designed to improve understanding of the physical processes in the Estuary and to identify routes for improving management were completed. Specifically, the *2008 Biological Opinion* RPA called for Sonoma Water to conduct "adaptive management of the outlet channel, investigation and possible elimination of impacts of the jetty at the river's mouth on lagoon formation, and alternative approaches to flood risk reduction (e.g., elevating structures or other methods)."	RPA Modification: Alterations to Estuary Management RPM 1: Undertake measures to ensure that harm and mortality to listed salmonids from adaptive management of the bar at the mouth of the Russian River are low.
Channel Maintenance on portions of the mainstem Russian River and Dry Creek	Sonoma Water has been conducting channel maintenance on Dry Creek and the MCRRF&WCID has been conducting channel maintenance on portions of the mainstem Russian River within Mendocino County. Actions are primarily related to maintenance of facilities associated with CVD and WSD operations.	RPM 5: Undertake measures to ensure that harm and mortality to listed salmonids resulting from channel maintenance activities in the mainstem Russian River, Dry Creek, and Zone 1A, are low.
Central Sonoma Watershed Project flood control facilities operations	Sonoma Water has been implementing passive operations of Central Sonoma Watershed Project flood control facilities including recently constructed bypass pipe at the Santa Rosa Creek diversion structure.	
Coyote Valley Fish Facility (CVFF) and Don Clausen Fish Hatchery (DCFH) Facilities Maintenance	Since publication of the *2008 Biological Opinion*, USACE has developed HGMPs at CVFF and DCFH. Prior development of HGMPs, hatchery management activities were conducted in compliance with the *2008 Biological Opinion*. Hatchery management activities have been managed consistent with HGMPs, each with their own, separate FESA coverage.	RPA Modification: Coho Broodstock Program Enhancements RPM 7: USACE (and CDFW) shall operate the DCFH and CVFF steelhead programs in a manner that minimizes adverse genetic effects to steelhead within the Russian River and within the CCC steelhead DPS.

TABLE 4-1 (CONTINUED)
SUMMARY OF PROJECT ELEMENTS INCLUDED IN THE ENVIRONMENTAL BASELINE AND STATUS

Project Element	Summary Description and Status	Relevant 2008 Biological Opinion RPAs and RPMs
Dry Creek Habitat Enhancements	Sonoma Water and USACE have been implementing, monitoring, and maintaining multiple habitat enhancements on Dry Creek since publication of the *2008 Biological Opinion*. Additionally, there are multiple projects in the planning stage.	RPA Modification: Dry Creek Habitat Enhancements RPM 5: Undertake measures to ensure that harm and mortality to listed salmonids resulting from Dry Creek and tributary habitat enhancements are low.
Physical and Biological Monitoring (Russian River watershed)	Sonoma Water and USACE have been conducting physical and biological monitoring in the Russian River watershed associated with current monitoring requirements and needs.	RPA Modification: Annual Monitoring of Salmonid Migration in the Russian River at Mirabel/Wohler and Dry Creek
Water Diversions at Mirabel and Wohler	In 2016 Sonoma Water replaced the fish screen and at the Mirabel/Wohler Bypass and the fish ladder on the west side of the river with a modern design to improve the passage of all species past the Mirabel Inflatable Dam.	RPM 6: Undertake measures to ensure that harm and mortality to listed salmonids from diversion operations, maintenance, and fish screen replacement at Wohler and Mirabel are low.

4.1 Watershed Overview

The Russian River originates in central Mendocino County, approximately 24 km north of the City of Ukiah and flows into the Pacific Ocean at Jenner, about 32 km west of the City of Santa Rosa. The Russian River watershed drains an area of approximately 3,846 square kilometers (km^2) , including much of Sonoma and Mendocino counties. The main channel of the Russian River is approximately 177 km long and runs generally southward from its headwaters near Redwood and Potter valleys to Forestville, where the channel’s direction changes to generally westward as the river crosses through a part of the Coast Ranges. Principal tributaries of the Russian River are the East Fork Russian River, Big Sulphur Creek, Maacama Creek, Dry Creek, Mark West Creek, and Austin Creek. Near the community of Duncans Mills, the lower section of the Russian River becomes an estuary (Russian River Estuary), where the tidal influence of the Pacific Ocean causes ocean water to mix with Russian River water, forming estuarine conditions.

4.2 Climate

Climate in the Russian River watershed is influenced by the watershed’s proximity to the Pacific Ocean. Precipitation patterns within the Russian River watershed reflect a Mediterranean climate, with hot, dry summers and cool, wet winters. Mean daily summer temperatures range from 72 to 75°F inland (with maximum temperatures in excess of 90°F) to 61 to 64°F near the coast, while precipitation normally falls during the wet season, October to May, with a large percentage of the rainfall typically occurring during three or four major winter storms. These major storms often come in the form of an Atmospheric River (AR), which is the horizontal transport of large amounts of water vapor through the atmosphere along a narrow corridor. Although brief, Atmospheric Rivers can produce 30 to 50% of the Russian River watershed’s annual precipitation during a few days.[65] Rainfall tends to be heaviest at higher elevations near the coast, with average annual rainfall of 80 inches per year near Cazadero at the western edge of the watershed. In lower elevation valley areas, annual precipitation ranges from 22 inches per year near Santa Rosa to 41 inches per year at the City of Healdsburg.[66] Winters are cool, but below-freezing temperatures seldom occur. Summers are warm and dry. A significant part of the region is subject to marine influence and fog intrusion. Prevailing winds are from the west and southwest.

Climatic conditions vary across different portions of the watershed. Average annual precipitation is as high as 80 inches in the mountainous coastal region of the watershed, and 20 to 30 inches in the valleys where most of the water users are located. Precipitation varies significantly from season to season, which results in a large amount of variability in river flows. Based on historical estimates of unimpaired flow developed by the USGS, the estimated water year unimpaired flow at the Hacienda Gage has ranged from a low of approximately 64,000 acre-feet in 1977 to a high of 3,871,000 acre-feet in 1983, with an average of 1,468,000 acre-feet per year (AFY) and a standard deviation of 874,000 AFY.[67,68]

4.3 Russian River Watershed

The Russian River watershed is 129 km long and 51 km across at its widest point, and lies within a series of narrow valleys between the Mendocino Range (part of the Pacific Coast Ranges) to the west, with elevations ranging from 1,500 to 3,000 feet, Mayacamas Mountains to the east, with elevations ranging from 3,000 to 4,000 feet, and Sonoma Mountains to the south. Hills and valleys make up most of the watershed (85%), while the remainder lies within alluvial valleys.[69] The highest point is Mount Saint Helena (4,344 feet). From its source, the Russian River flows through several physiographically distinct sections beginning with an upper section comprised of a series of northwest trending alluvial valleys separated by bedrock constrictions that form the Ukiah, Hopland and Alexander valleys. The valleys occur along fault traces within extensional valleys formed by recent tectonic activity. A middle section begins near the City of Healdsburg where the river turns abruptly west through a sinuous bedrock canyon, then south through an alluvial valley confined by a bedrock constriction near the Wohler Bridge near Forestville. The lower portion flows west through a series of canyons and alluvial valleys cutting across the Coast Ranges to the Russian River Estuary and the Pacific Ocean.

Vegetation and landcover reflect climate, and past and present land use. The watershed transitions from a dry interior portion dominated by hardwood forests, oak savannah, chaparral, and grasslands, to a fog-influenced portion near the coast characterized by conifer forest.[70] Early (circa 1800) land uses included cattle and horse ranching, leading to conversion from forest to grassland

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[65] Flint, L.E., Flint, A.L., Curtis, J.A., Delaney, C., and Mendoza, J. 2015. Provisional simulated unimpaired mean daily streamflow in the Russian River and upper Eel River Basins, California, under historical and projected future climates: U.S. Geological Survey Data Release.

[66] PRISM, 2021. *Op. cit.*

[67] Unimpaired flows are summarized as acre-feet per water year. A water year is the 12-month period for any given year between October 1 and September 30 of the following year.

[68] SCWA, 2016. *Op. cit*.

[69] Entrix, Inc. 2004. Russian River Biological Assessment. Prepared for Sonoma Water.

[70] Gasith, A. and Resh, V.H. 1999. Streams in Mediterranean climate regions: abiotic influences and biotic responses to predictable seasonal events. Annual Review of Ecology and Systematics. 30:51-81.

and general narrowing of the forested riparian corridor. The California Gold Rush of 1849 hastened the settlement of the watershed and increased demand for wood and agricultural products. Greater need for transportation and shipping routes led to gravel and sand extraction from the Russian River and its floodplains to build railroad corridors and wider, more accommodating roads and highways. Flood control practices further altered the river through channel straightening and levee construction. Current land use is dominated by agriculture (viticulture, orchards), sheep and cattle grazing, suburban and exurban development, and urban centers (Santa Rosa/Rohnert Park [population 220,000] and Windsor/Healdsburg [population 40,000]) and is guided by general plans approved by incorporated communities and the County of Sonoma.

Coyote Valley Dam forms Lake Mendocino and impounds water from 272 km^2 of the upper watershed on the East Fork Russian River (approximately 7 percent of the entire Russian River basin), just upstream of the confluence with the mainstem Russian River. The dam impounds water coming from the East Fork Russian River through Potter Valley into Lake Mendocino. This section of the East Fork Russian River also receives water from PG&E’s PVP, which transfers water from the Eel River through a tunnel and penstocks at the watershed divide between the Eel and the Russian rivers. Downstream of Coyote Valley Dam, the East Fork Russian River flows into the mainstem Russian River near Ukiah. The Russian River then flows through a series of alluvial valleys and an occasionally closed estuary before reaching the Pacific Ocean.

4.3.1 Major Tributaries

Several major tributaries (including the East Fork) enter the Russian River between Coyote Valley Dam and the Pacific Ocean (**Table 4-2** and **Figure 4-1**).[71] The East Fork Russian River enters the mainstem upstream of Ukiah, with Robinson Creek entering just downstream of Ukiah from the east, Feliz Creek entering from the west near Hopland, and Big Sulphur draining from the east near Cloverdale. Maacama Creek joins the mainstem upstream of Healdsburg. Dry Creek drains much of the western half of the Russian River watershed and enters downstream of Healdsburg. Mark West Creek enters the Russian River from the east at Mirabel Park near Forestville and drains approximately 658 km^2. The Dry Creek and Mark West Creek watersheds are the largest sub-watersheds in the Russian River system. The Laguna de Santa Rosa (440 km^2), which includes the Santa Rosa Creek sub-watershed, empties into Mark West Creek approximately 4 km upstream from its confluence with the Russian River and is a natural overflow basin for the Russian River. After flowing past Mark West Creek, the Russian River turns west and flows past Austin Creek into the Russian River Estuary before entering the Pacific Ocean near Jenner.

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[71] USACE, 1982. Northern California Streams Investigation: Russian River Basin Study. San Francisco, Ca. 231 pp. USACE.

SOURCE: NHD (2021)

Figure 4-1
Russian River Sub-Watershed and USGS Gauges

TABLE 4-2
MAJOR TRIBUTARIES TO THE RUSSIAN RIVER

Tributary	Sub-Watershed Drainage Area (km^2)	Russian River Kilometer (km)
East Fork Russian River	262	159
Robinson Creek	65	155
Feliz Creek	109	122
Big Sulphur Creek	223	100
Maacama Creek	181	66
Dry Creek	562	50
Mark West Creek	658	34
Austin Creek	181	10
Russian River at Mouth	3,846	0

SOURCE: USACE, 1982. Northern California Streams Investigation: Russian River Basin Study. San Francisco, Ca. 231 pp.

4.3.2 Regional Hydrology

4.3.2.1 Surface Water

The California Water Plan divides California into 10 hydrologic regions, based upon the state's major drainage basins. Each of these basins has distinct precipitation and runoff characteristics.[72] The action area is within the North Coast Hydrologic Region. The region encompasses 50,220 km^2 and is divided into the Klamath River and the North Coastal subbasins. The North Coast Hydrologic Region includes all of Del Norte, Humboldt, Trinity, and Mendocino counties, major portions of Modoc, Siskiyou, and Sonoma counties,[73] and portions of Glenn, Lake, and Marin counties. Characteristic topographic features are the California Coast Ranges, the Klamath Mountains and the Modoc Plateau, with elevations averaging 6,000 feet along the eastern boundary and a few peaks greater than 8,000 feet (Mount Shasta is the tallest peak at over 14,000 feet) to sea level along the western edge.

The North Coast Hydrologic Region is the most water abundant in California, subject to heavy rainfall that yields 41% of the state's natural annual runoff (29 million acre-feet).[74] Most of the precipitation is rainfall, which averages 50 inches per year, but ranges from 100 inches per year along the coast to 15 inches per year in dry inland regions. A small fraction falls as snow at elevations greater than 4,000 feet. The North Coastal sub-basin encompasses the entire action area and covers an area of approximately 22,170 km^2 along the north-central California Coast.[75] The sub-basin is bounded by the Pacific Ocean to the west; the Klamath and Trinity River Basins to the north; the Sacramento Valley, Clear Lake, Putah and Cache Creek Basins, and the Napa River Basin to the east; and the Marin-Sonoma county line to the south. The sub-basin covers all

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[72] California Department of Water Resources (DWR), 2013. California's Groundwater Update: A compilation of enhanced content for the California Water Plan Update, April 2015. North Coast Hydrologic Region.

[73] Inclusive of the Russian River watershed.

[74] California Department of Water Resources (DWR), 2009. California Water Plan, Volume 3, North Coast Integrated Water Management. Northern Region Office, Red Bluff, Ca.

[75] North Coast Water Quality Control Board (NCRWQCB), 2018. *Op. cit.*

of Mendocino County, major portions of Humboldt and Sonoma counties, about one-fifth of Trinity County, and small portions of Glenn, Lake and Marin counties. Most of the sub-basin consists of rugged, forested coastal mountains dissected by six major river systems: Mad, Eel, Noyo, Navarro, Gualala, and Russian, Rivers, and numerous smaller river systems. Soils are generally unstable and erodible, and rainfall is high.[76]

4.3.2.2 Groundwater

Groundwater resources in the North Coast Hydrologic Region occur along the coast near major river mouths, on marine terraces, or inland river valleys and basin.[77] Reliability of these resources varies, but DWR (2003) delineated 63 groundwater basins (divided into 551 basin/sub-basins) in the region underlying approximately 1.022 million acres (4,144 km^2). Along the coast, most groundwater comes from shallow wells in alluvium (sand and gravel) underlying the region's rivers.

The Russian River watershed contains three general geologic formation assemblages differentiated by age and water bearing properties.[78] The oldest geologic formations (Jurassic and Cretaceous age) are rocks of the Franciscan, Great Valley and Coast Range Ophiolite, which occur as bedrock along the northern Coast Ranges and provide limited amounts of groundwater (through fracture flow) for primarily domestic use in mountain areas. Younger geologic formations of Pliocene and Pleistocene age (Sonoma volcanics, Wilson Grove [formerly Merced] formation, Glen Ellen formation) primarily occur in the southern portions of the action area and host significant aquifer systems which are utilized by municipal, agricultural, commercial and rural domestic groundwater users. The youngest geologic formations are Quaternary and more recent alluvial deposits. Following the Wisconsin Glaciation, sea level rise caused the deposit of clay, sand, and gravel within the Russian River valley. This unconsolidated sediment deposited as deltaic fans, floodplains, stream channels, and remains as terraces and other river landforms.[79] The Quaternary alluvial deposits along the main stem of the Russian River, where sufficiently thick and saturated, comprise the most productive aquifer in the action area and are a high yield source for municipal, rural domestic and agricultural needs. In areas where the Quaternary alluvial deposits are relatively thin, such as near the margins of the valley, older formations, including the Glen Ellen Formation and Sonoma Volcanics (where present) are more commonly tapped by water wells.[80]

Within the action area groundwater resources encompass several groundwater basins and sub-basins as defined by Bulletin 118 of the California Department of Water Resources (**Table 4-3**).

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76 North Coast Resource Partnership, 2014. North Coast Integrated Water Resource Management Plan, Phase III. August 2014.

77 DWR. 2003. California's Groundwater: Bulletin 18. State of California, Sacramento, CA 2003. California Department of Water Resources.

78 Caldwell, G.T. 1965. Geology and Ground Water in Russian River Valley Areas and in Round, Laytonville and Little Lake Valleys Sonoma and Mendocino Counties, California. California Geological Survey, Water Supply Paper 1548, Prepared in Cooperation with California Department of Water Resources.

79 Florsheim JL, Goodwin P (Philip Williams and Associates Ltd., San Francisco, CA). 1995. Geomorphic and hydrologic conditions in the Russian River, California: Historic trends and existing conditions. Revised 1995. [place unknown]: California State Coastal Conservancy, Mendocino County Water Agency, Circuit Rider Productions, Inc.

80 USGS. 2006. Geohydrology and Water Chemistry of the Alexander Valley, Sonoma County, California. By L. F. Metzger, C. D. Farrar, K.M. Koczot, and E. Reichard (Scientific Investigations Report -2006-5115). In Cooperation with the Sonoma County Water Agency. July 2006. United States Geological Survey.

The upper Russian River includes the Ukiah Valley (California groundwater basin #1-52), Sanel Valley (California groundwater basin #1-53), and Alexander Valley (California groundwater basin #1-54) groundwater basins. DWR (2003) further divides the Alexander Valley groundwater basin into the Alexander (#1-54.01) and Cloverdale (#1.54.02) sub-basins, which both occur in the upper Russian River. The Healdsburg Area sub-basin (California groundwater sub-basin #1-55.02) of the Santa Rosa Valley basin (DWR 2003) straddles the Dry Creek Reach and southern end of the upper Russian River. The lower Russian River includes the Lower Russian River groundwater basin (California groundwater basin #1-60). The majority of the Wilson Grove Formation Highlands (California groundwater basin #1-59) groundwater basin is located in the southern portions of the action area. The Santa Rosa Plain sub-basin (California groundwater sub-basin #1-55.01, part of the Santa Rosa Valley groundwater basin [#1-55]) is tributary to the action area and aquifer systems within the Santa Rosa Plain. Within the action area, only the Ukiah Valley groundwater basin and the Santa Rosa Plain groundwater subbasin are required to comply with the Sustainable Groundwater Management Act (SGMA) and have developed Groundwater Sustainability Plans (GSPs) to locally manage and sustain groundwater resources.

TABLE 4-3
GROUNDWATER BASINS FOUND WITHIN THE ACTION AREA

Groundwater Basin (#)	Sub-Basin	Acres
Ukiah Valley (1-52)	None	37,500
Sanel Valley (1-53)	None	5,570
Alexander Valley (1-54)	Alexander (1-54.01)	24,500
	Cloverdale (1-54.02)	6,500
Santa Rosa Valley (1-55)	Santa Rosa Plain (1-55.01)	15,400
	Healdsburg (1-55.02)	80,000
Lower Russian River (1-60)	None	6,600

SOURCE: DWR, 2003. California’s Groundwater: Bulleting 18. State of California, Sacramento, CA 2003.

The basins and sub-basins range in size from 5,570 to 80,000 acres and are utilized to varying degrees for water supply. The groundwater basins and sub-basins are mapped based on the surficial distribution of alluvial geologic formations and include areas with shallow alluvial aquifer systems that are most likely to exhibit direct hydraulic communication with surface water systems. Other aquifer systems that underlie the action area primarily occur within fractured bedrock of the Franciscan Complex, Great Valley Sequence and Coast Range Ophiolite and are more limited and sporadic in their occurrence and connection with the affected surface water systems.

Detailed groundwater budgets, an analysis of inflows and outflows useful for estimating storage change, have not been developed for most of the basins and sub-basins in the action area. As required by SGMA, groundwater budgets have been developed for the Ukiah Valley groundwater basin and the Santa Rosa Plain groundwater subbasin. USGS (2006) also conducted a study of the hydrogeology and water chemistry of the Alexander Valley which included a preliminary water budget. The estimated total water use for the Alexander Valley for 1999 was approximately

15,800 ac-ft. About 13,500 ac-ft of this amount was estimated to be for agricultural use, primarily vineyards, and about 2,300 ac-ft was for municipal/industrial use. Groundwater was reported to be the main source of water supply (estimated to meet 78% of the total water demands) in the basin, although the estimate may include some diversions made through wells under surface water rights.[81]

In 2015, the USGS, in cooperation with Sonoma Water and the SWRCB, initiated a hydrologic study that will refine understanding of the hydrologic system and provide an integrated watershed/groundwater-flow model of the Russian River watershed. This cooperative project will provide hydrologic information, including water budget estimates to better understand the potential impacts of climate variability and change, and associated changes in groundwater use on groundwater levels, stream discharge, stream-aquifer interaction, and water quality. The study includes development of an integrated hydrologic and reservoir/river operations model to inform water resource management of the watershed. The study is anticipated to be completed in 2023.

In the portions of the action area where groundwater is most closely connected to the Russian River mainstem and Dry Creek, the principal inflows to groundwater are precipitation and surface water from rivers and streams. Seasonal groundwater-level fluctuations vary from one to two feet (primarily along Dry Creek) to five to 10 feet in other areas.[82] The seasonal high groundwater-levels generally correspond with high river and stream flows and indicate that groundwater within the alluvial aquifer is in close hydraulic communication with surface water. Groundwater-levels in the southern portion of the Healdsburg area sub-basin are also locally influenced by a series of quarry ponds which have been excavated along the middle reach of the Russian River. In general, during the rainy season with high river flows (typically late-fall through early spring surface water overtops banks and floodplains, infiltrating into and recharging unconfined aquifers. As flow and water surfaces decline to elevations lower than the adjacent groundwater table (typically late-spring to early summer), surface water is gained as aquifers discharge into rivers and stream channels, contributing baseflow to the rivers and streams. Through the summer and early-fall, the groundwater table elevation can gradually drop below surface water surface elevation along some reaches, and streamflow enters the aquifer. Additionally, in areas where groundwater is pumped through wells located near the river, streamflow depletion can occur and locally result in losing river conditions.

4.3.3 Regional Geomorphology

The current geomorphic condition of the Russian River and Dry Creek reflects the transformation and intensity of past and current land uses. Prior to European settlement in 1850, forests covered much of the Russian River and Dry Creek valleys, which were subject to dynamic fluvial interaction and characterized by large gravel bars, forested islands, side-channels and sloughs. These landforms became less prevalent, and watercourses less dynamic, as timber harvest, grazing, agriculture, gravel mining, and water storage and regulation increased. The Russian River and Dry Creek responded by incising into their alluvial valleys, changing the hydraulic

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[81] USGS. 2006. *Op. cit.*

[82] Sonoma Water, 2016. *Op. cit.*

environment from relatively wide and shallow to narrow and deep, and simplifying or eliminating fluvial landforms that provided habitat for aquatic and riparian biota.

Several sources summarize a narrative history of land-use changes and river response and examine recently collected survey data to describe and characterize the historical and current geomorphic condition of the Russian River from Coyote Valley Dam to the Pacific Ocean and Dry Creek.[83,84,85] The narrative history and survey data show systemic changes through both basins from 1850 to present. Survey data were collected by different agencies (USACE, DWR, and FEMA) for various purposes. Consequently, the data occur at irregular spatial scales and time intervals. Nonetheless, the data show a pattern of channel incision and geomorphic change along the length of the Russian River and Dry Creek.

Prior to 1850, the wide alluvial portions of the Russian River meandered across adjacent floodplains while bedrock sections remained confined within narrow canyons. Shortly after European settlement, channel stabilization by local landowners attempted to preserve and fix parcel boundaries surveyed from the centerline of the active channel to the land surface. Agricultural practices filled side-channels and sloughs and removed riparian vegetation to further increase land area. In 1908, the Potter Valley Project brought water from the Eel River into the Russian River, increasing flow during dry months. Florsheim and Goodwin (1995) note that this was the beginning of summer flow in the Russian River, as prior to 1908 flow reduced to a trickle, but surface water remained in pools, disconnected sloughs and side channels.[86] Cultivation and agricultural activity increased through the 1940s, while demand for aggregate and sand intensified leading to gravel mining, and in-channel debris clearing to reduce flooding became common practice. The completion of Coyote Valley Dam in 1959 altered the hydrograph and sediment transport from the East Fork Russian River to the mainstem Russian River.

4.3.4 Upper Russian River

4.3.4.1 Hydrology

There are eight USGS stream gages along the upper mainstem Russian River and two gages on tributaries entering the upper Russian River, all with varying periods of record (**Table 4-4**). Focusing on the four gages with the longest periods of record and that encompass the upper Russian River from the mainstem just upstream of the confluence at the East Fork through Hopland to Healdsburg (Russian River near Ukiah, USGS gage No. 1146100; Russian River near Hopland, USGS gage No. 11462500; Russian River near Cloverdale, USGS gage No. 11463000; Russian River near Healdsburg, USGS gage No. 11464000), all show the same median monthly flow pattern with high flow in the winter and low flow in the summer. Mean monthly flow is greatest in February and lowest from June through October, reflecting the Mediterranean climate.

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[83] Harvey MD, Schumm SA (Water Engineering and Technology, Inc., Fort Collins, CO), 1985. Geomorphic analysis of Dry Creek, Sonoma County, California from Warm Springs Dam to Russian River confluence. Sacramento (CA): USACE. Contract No.: DACW05-85-P0064.

[84] Simons, Li and Associates 1991. Hydrologic Impacts of Gravel Mining on the Russian River. Prepared for Sonoma County Department of Planning, Santa Rosa, CA. February 1991.

[85] Swanson, M.L 1992. Hydrologic and Geomorphic Impact Analysis of the Proposed Reclamation Plans at Syar Industries Properties in the Russian River near Healdsburg, Sonoma County, CA. Prepared for EIP Associates, Sacramento, CA.

[86] Florsheim JL, Goodwin P. 1995. *Op. cit.*

Discharge at the Russian River near Ukiah stream gage is lowest across all months as it is the most upstream and has the least contributing area of all gages along the mainstem. The gage is also upstream of the confluence with the East Fork Russian River and is not affected by releases from Coyote Valley Dam. As such, this point is typically dry or nearly dry from late-summer to early-fall. Downstream of Ukiah, flow is nearly constant from June through October at the Hopland, Cloverdale, and Healdsburg gages owing to release flows from Coyote Valley Dam to meet minimum instream flow requirements. Prior to the dam, the river experienced greater median monthly winter flows that peaked in January and lower, more variable summer flow. Regulation muted winter peak flows (compared to unregulated conditions) and stabilized flow from June through October, reflecting dam operation for flood control and water supply.

TABLE 4-4
USGS FLOW GAGES ALONG THE UPPER RUSSIAN RIVER

Gage Name	Gage No.	Drainage Area (m^2)	Period of Record
Russian River near Ukiah	11461000	100	1991-present
Russian River near Talmage	11462080	286	2009-present
Russian River near Hopland	11462500	362	1939-present
Russian River near Cloverdale	11463000	503	1951-present
Russian River near Geyserville	11463500	655	1910-1913; 2013-present
Russian River near Jimtown	11463682	684	2009-present
Russian River near Digger Bend	11463980	791	1987-present
Russian River near Healdsburg	11464000	793	1930-present
Big Sulphur near Cloverdale	11463200	86	1957-1972; 1989-present
Maacama near Kellogg	11463900	44	1961-1981; 2013-present

SOURCE: Sonoma County Water Agency (SCWA), 2016. Fish Habitat Flows and Water Rights Project Draft Environmental Impact Report. July 2016.

4.3.4.2 Geomorphology

Through the upper Russian River, beginning in Mendocino County, aerial photographs show minimal change in channel width or sinuosity from the 1950s to the 1990s, but a comparison of longitudinal profiles and cross sections show substantial adjustment to land-use changes. Long profiles from 1940 and 1979 showed that bed elevations lowered 10 to 18 feet just downstream of Coyote Valley Dam between rkm 135.2 and 151.3, while later surveys (1979 and 1989) showed 5 feet of incision between Feliz Creek in Hopland, and the Highway 101 bridge crossing. Cross-sections collected in 1980, 1981, and 1982 at tributary junctions and bridge crossings show increases in channel area at Dooley Creek, Forsythe Creek, and Robinson Creek and in the Russian River at Highway 175 corresponding to incision and channel widening. Other field evidence of incision includes construction of grade control structures on Ackerman, Hensley, and Robinson creeks intended to prevent downcutting on bridge piers as tributary bed elevation lowered in response to coincident lowering on the Russian River.

Historical management, aerial photographs and maps indicate substantial planform change through the Alexander Valley and survey data show channel incision similar to incision upstream through Mendocino County. Levees constructed in the 1930s confined a portion of the river from Big Sulphur Creek to the Cloverdale Airport, and USACE and Sonoma Water began channel maintenance activities in 1959 after construction of Coyote Valley Dam. In conjunction with the Coyote Valley Dam project, USACE constructed channel stabilization works from 1956 to 1963 that included channel clearing, pilot channels (conversion of a meander to a straight portion of river), bank protection works, including anchored steel jacks, wire mesh gravel revetments, and check dams.[87] Historical topographic maps and aerial photography show channel planform transforming from a sinuous channel surrounded by a wide riparian area to a straight channel surrounded by stabilization measures, agriculture, and gravel mining. Simons, Li and Associates (1991) monitored channel change through the Alexander Valley using aerial photographs from 1981 to 1986 and observed localized bank failure that eroded riparian vegetation and surrounding undeveloped and cultivated lands.[88] They also noted meander migration within the active channel along a portion of the valley. Sequential longitudinal profiles from 1971 and 1991 by USACE and Sonoma Water show 20 feet of channel degradation (incision) in the lower Alexander Valley, with some localized aggradation associated with channel widening. Sequential cross-sections also indicate channel lowering and localized channel widening, likely related to flooding induced bank erosion.

4.3.5 Lower Russian River

4.3.5.1 Hydrology

There are two USGS flow gages in the lower Russian River, located at the Hacienda Bridge (Russian River near Guerneville, USGS Gage No. 11467000) and near Riverfront Regional Park (Russian River near Windsor, USGS Gage No. 11465390). In addition, there are two gages in tributaries near junctions with the mainstem Russian River (Mark West Creek near Mirabel Heights and Austin Creek near Cazadero) (**Table 4-5**). The Russian River near Guerneville gage shows similar seasonal trends as the upper Russian River and Dry Creek with flows highest during winter and spring, and lowest during summer and fall. Instream flow is substantially higher in the winter and spring compared to the upper Russian River or Dry Creek, due to a larger contributing area, but similar to the upper Russian River in the summer and fall. The period of record for the Russian River near Guerneville gage encompasses pre- and post-regulation by Coyote Valley (before 1959) and Warm Springs (before 1984) dams. Gage records show that Coyote Valley Dam had a minor effect on winter median monthly flows as it controls only 7 percent of the total watershed area (the dam did have an effect on the duration and timing of flood peaks associated with impoundment). Warm Springs Dam had a greater effect on winter median monthly flows as it controls a greater area (339 versus 272 mi^2) on a tributary (Dry Creek) that contributes the largest annual runoff to the Russian River.[89] Under pre- and post-Coyote Valley and Warm Springs dam regulation, median monthly flow was consistent, but low, during the summer and fall.

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[87] USACE. 1997. Russian River Ecosystem Restoration Reconnaissance Report, Mendocino and Sonoma Counties, California. San Francisco, CA. United States Army Corps of Engineers San Francisco District.

[88] Simons, Li and Associates 1991. *Op. cit.*

[89] USACE, 1984. *Op. cit.*

TABLE 4-5
USGS FLOW GAGES ALONG THE LOWER RUSSIAN RIVER

Gage Name	Gage No.	Drainage Area (km^2)	Period of Record
Russian River near Guerneville	11467000	3,465	1939-present
Russian River near Windsor	11465390	2,647	2009-present
Mark West Creek near Mirabel Hts	11466800	650	2005-present
Austin Creek near Cazadero	11467200	163	1959-present

SOURCE: Sonoma County Water Agency (SCWA), 2016. Fish Habitat Flows and Water Rights Project Draft Environmental Impact Report. July 2016.

4.3.5.2 Geomorphology

The lower Russian River flows generally south through a heavily modified alluvial section before entering a confined canyon cutting across the Coast Ranges that leads to the Russian River Estuary and the Pacific Ocean. In the alluvial section, aerial photographs from the 1940s and 1950s show intense floodplain and channel modification from gravel mining and flood control activities, while historical topographic maps document the river corridor changing from a wide riparian area with a sinuous channel (1864) to a narrow, straight channel (1980) subject to bank stabilization and agricultural development.[90] Longitudinal profiles through this portion indicate channel incision of up to 20 feet, likely due to instream gravel mining in combination with dam operations. The primary gravel extraction method on the Russian River in the 1940s was deep dredging of the active channel, which occurred in the alluvial section of the lower Russian River to depths of 30 to 60 feet.[91] Regulations later limited gravel mining to bar skimming and floodplain excavation (gravel pits), but intensive gravel mining from the 1940s to the 1970s lowered bed elevation between Dry Creek and Wohler Bridge by up to 18 feet. As noted above, Dry Creek incised by up to 10 feet in response to lower bed elevations in the Russian River.[92] The canyon section of the lower Russian River is relatively stable compared to upstream areas (including the upper Russian River and Dry Creek), although approximately 12 feet of incision at the Monte Rio Bridge has occurred since 1934 (but little since 1973). The estuarine portion of the lower Russian River extends 9.7 to 11.3 km upstream from the mouth of the Russian River to the confluence of Austin Creek, with bed elevations generally below sea level up to rkm 19.3. A barrier beach occasionally forms across the mouth of the river, impounding water to form a lagoon. The sandbar opens naturally when hydraulic conditions in the Russian River and Pacific Ocean change, or when it is artificially breached. When the sandbar is open, the Estuary is open to tidal mixing (see Section 4.3.7, *Russian River Estuary*).

4.3.5.3 Central Sonoma Watershed Project

In 1958, the Sonoma County Flood Control and Water Conservation District (now Sonoma Water), Santa Rosa Soil Conservation District (now Sonoma Resource Conservation District), and the USDA Soil Conservation Service (now Natural Resources Conservation Service (NRCS))

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[90] Florsheim J.L., Goodwin P. (Philip Williams and Associates Ltd., San Francisco, CA). 1995. *Op. cit.*

[91] Swanson, M.L. 1992. *Op. cit.*

[92] Harvey M.D., Schumm S.A., 1985. *Op. cit.*

developed the Central Sonoma Watershed Work Plan (1958 Plan) to combat recurring flood damage in Sonoma County. The 1958 Plan covered 163,000 acres of the Laguna de Santa Rosa, Mark West, and Santa Rosa Creek watersheds; however, it explicitly focused on mitigating flooding in the 50,000-acre Santa Rosa Creek sub-watershed with an integrated network of channels, culverts, bridges, conduits, reservoirs, outfalls, and diversion structures collectively known as the Central Sonoma Watershed Project (CSWP).

The purpose of the work plan was to design and implement projects to alleviate flooding within the Santa Rosa Creek sub-watershed. These projects included the construction of floodwater retarding structures (detention reservoirs), diversion structures, culverts, and the straightening, shaping, and stabilization of waterways. Sonoma Water is tasked with operation and maintenance of all structural measures included in the CSWP as further described below.

Flood Control Reservoirs

The CSWP includes Santa Rosa Creek (Spring Lake), Matanzas Creek, Piner Creek (located on Paulin Creek) and Middle Fork Brush Creek reservoirs (**Figure 4-2**). Each reservoir is designed to reduce flood risk by temporarily impounding flood waters and releasing them in a controlled manner. All on-stream CSWP reservoirs (Brush Creek, Matanzas, and Piner) function as passive flow-through structures that maintain continuity of base flows by routing discharge to downstream channels with passive low-level drains that are open throughout the year. In general, fish passage facilities are not provided at any of the on-stream reservoirs or the diversion on Spring Creek. Therefore, Brush Creek, Piner, and Matanzas Creek reservoirs are complete barriers to anadromy. The Vortex Tube and fish ladder are part of the Santa Rosa Creek Diversion facility and facilitate anadromous fish passage The diversion structure passes flood flows from Santa Rosa Creek to Santa Rosa Reservoir to reduce downstream flood risk. Additional descriptions of each flood control reservoir are provided below.

Santa Rosa Reservoir (Spring Lake)

The Santa Rosa Creek Reservoir is an off-stream facility adjacent to Santa Rosa Creek (Figure 4-2) that was constructed between 1962 and 1963. The reservoir has an original reported capacity of 3,550 acre-feet at the crest of the auxiliary spillway including a permanent pool storage of 126-acre feet.[93] Recent analysis using the 2013 Countywide Light Detection and Ranging (LiDAR) by Sonoma Water indicates storage between the permanent pool and auxiliary spillways is approximately 3,430 acre-feet. The reservoir is formed by an earthen embankment adjacent to Montgomery Drive (main dam) and Santa Rosa Creek; a saddle dam along the northwestern edge of the reservoir (west saddle dam); a saddle dam along the southern edge of the reservoir (south saddle dam) at the end of Newanga Avenue; and a principal spillway and a concrete chute auxiliary spillway. The principal spillway consists of a concrete riser inlet structure with a trash rack and a 12-inch diameter low-level drain regulated by a 1-foot diameter gate valve normally operated in the closed position. The normally closed gate valve in the principal spillway structure creates the shallow (maximum depth of 15 feet) year-round Spring

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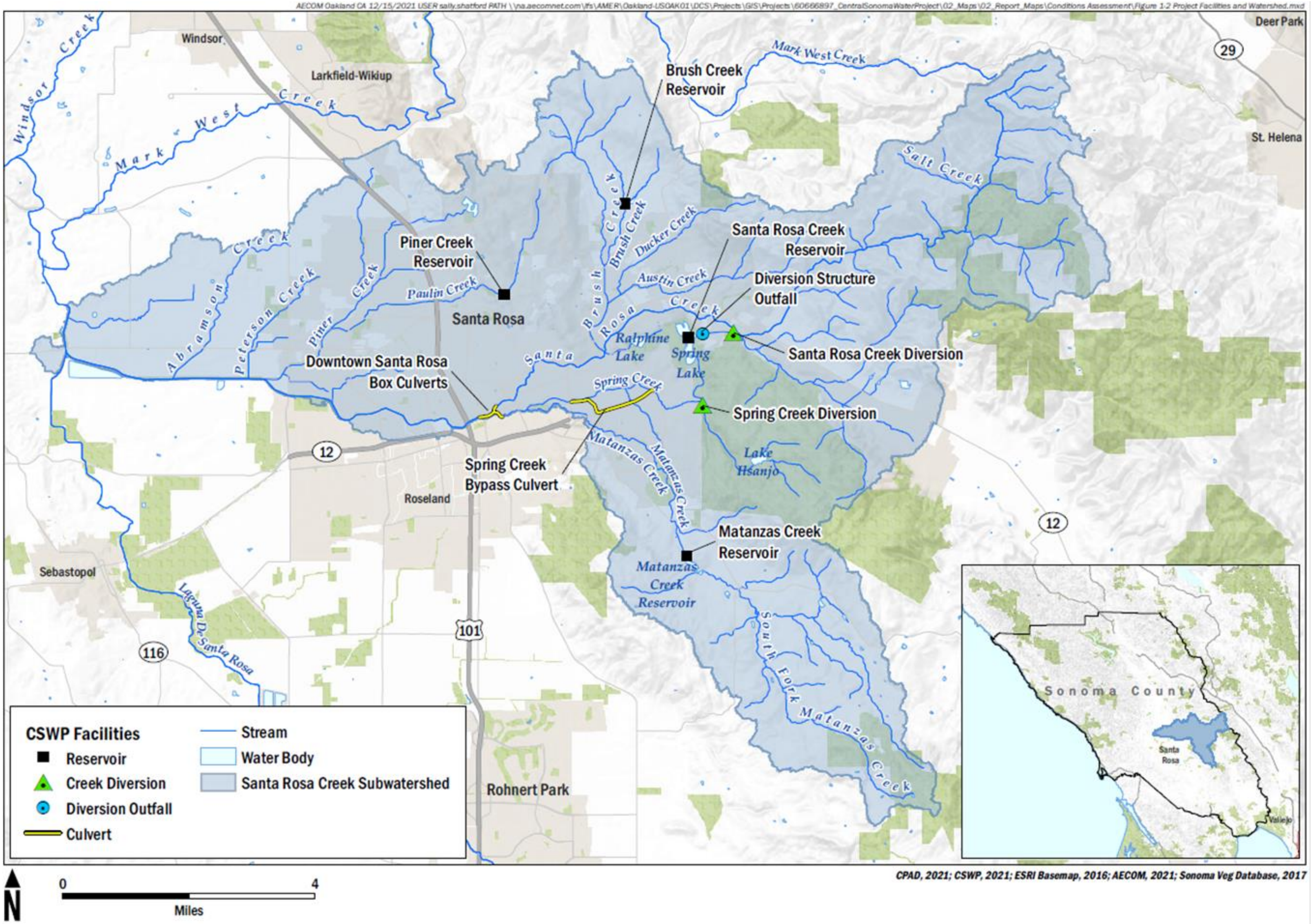
[93] USDA. 2017. Assessment Report, Santa Rosa Creek Dam, Sonoma County. May.



CPAD, 2021; CSWP, 2021; ESRI Basemap, 2016; AECOM, 2021; Sonoma Veg Database, 2017

Figure 4-2
CSWP Flood Facilities and Watershed Map

Lake. The principal spillway inlet structure and low-level drain discharge into a 60-inch reinforced concrete pipe (RCP), which conveys flow for approximately 327 feet to a concrete rectangular channel. The rectangular concrete channel extends an additional 440 feet and crosses below Montgomery Drive before discharging into Santa Rosa Creek. The auxiliary spillway consists of a concrete drop structure at the eastern end of the main dam, where flows spill over the crest walls into a 12-foot-deep, 45--foot-wide concrete channel. Flow continues down a concrete spillway chute to an energy dissipater/baffle block stilling basin before rejoining Santa Rosa Creek.

Santa Rosa Creek Reservoir passively fills in an episodic manner due to wet-season storm events by way of the Santa Rosa and Spring Creek Diversions and local ephemeral drainages emanating from the surrounding landscape. Santa Rosa Creek Reservoir has a permanent pool throughout the year. In the early spring and after rainfall events the reservoir quickly equilibrates to the principal spillway elevation and forms a 90-acre recreational pool. Between late spring and late fall, Santa Rosa Creek Reservoir typically lowers by 2 to 4 feet due to evaporation and cessation of near-surface groundwater inputs. The low-level drain can be used to reduce the pool elevation by up to seven feet to facilitate maintenance and dam safety inspection. Because the drain is operated in a closed position, water in Spring Lake does not discharge into Santa Rosa Creek during normal (non-flood event) operations.

Matanzas Reservoir

The Matanzas Creek Reservoir was built in 1964 and consists of a main earthen embankment across Matanzas Creek in Bennett Valley (Figure 4-2). The reservoir has an original reported capacity of 1,520 acre-feet at the crest of the auxiliary spillway, however recent analysis using the 2013 Countywide LiDAR indicates storage is approximately 1,445 acre-feet.[94,95] The reservoir includes a principal spillway inlet, conduit, and outfall; and a vegetated earthen auxiliary spillway. The main dam embankment is approximately 685 feet long, with a maximum height of 95 feet and a crest width of approximately 24 feet. The principal spillway consists of a concrete riser inlet structure with a trash rack and an 18-inch diameter low-level drain regulated by a gate valve that is operated in the open position. The low-level drain and inlet structure discharges into a 5.25-foot by 5.25-foot rectangular cast-in-place reinforced concrete conduit, which conveys flow for approximately 450 feet to the outfall concrete stilling basin and natural Matanzas Creek channel. The auxiliary spillway consists of a vegetated earthen, broad-crested weir with a concrete control sill at the upstream extent of the spillway. The crest of the auxiliary spillway is at elevation 412.6 feet (NAVD88); it has a bottom width of 200 feet and 2H:1V side slopes. The outlet channel bottom width tapers to approximately 80 feet over a distance of 300 feet before rejoining Matanzas Creek downstream of the principal spillway outfall. The reservoir extends to the east of the dam, to primarily undeveloped Sonoma Water property and adjacent rural residential parcels.

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[94] HDR/Kleinfelder Joint Venture. 2016. California Dam Assessment for Matanzas Creek Dam, Sonoma County, CA. Prepared for USDA, NRCS, California State office. April.

[95] JDE (Jones & DeMille Engineering, Incorporated) and AECOM. 2021. TM005 – Existing Hydrology Analysis, Matanzas Creek Dam Supplemental Watershed Plan – ED. October.

Piner Creek Reservoir

The Piner Creek Reservoir was completed in 1964 along Paulin Creek and is currently owned, operated, and maintained by Sonoma Water. The reservoir has an original reported capacity of 155 acre-feet at the crest of the auxiliary spillway; however recent analysis using the 2013 Countywide LiDAR by Sonoma Water indicates storage is approximately 124 acre-feet.[96] The facility consists of a main earthen embankment across Paulin Creek; an adjacent saddle dam earthen embankment; a principal spillway inlet, conduit, and outfall; and an auxiliary concrete chute spillway and outfall stilling basin. The principal spillway consists of a concrete riser inlet structure with a trash rack and a 12-inch diameter low-level drain regulated by a slide gate operated in the open position. The inlet structure and low-level drain discharges into a 54-inch RCP, which conveys flow for approximately 188 feet to the outfall concrete stilling basin and natural Paulin Creek channel. The auxiliary spillway consists of a concrete drop structure where flows spill over the crest walls into an 11-foot-deep, 30--foot-wide concrete channel. Flow continues down a concrete spillway chute to an energy dissipater/baffle block stilling basin. The reservoir extends to the east and north of the dam, bordered by residential development to the south, the Sonoma County Behavior Health facility to the east, and a private parcel adjacent to Chanate Road to the north. The reservoir consists primarily of undeveloped land that is vegetated with grass and small diameter riparian-associated tree species.

Brush Creek Reservoir

The Brush Creek Reservoir was completed in 1962 and is currently owned, operated, and maintained by Sonoma Water (Figure 4-2). The reservoir has an original reported capacity of 141 acre-feet at the crest of the auxiliary spillway; however recent analysis using the 2013 Countywide LiDAR by Sonoma Water indicates storage is approximately 112 acre-feet.[97] The facility consists of a main earthen embankment across Brush Creek Middle Fork; a principal spillway inlet, conduit, and outfall; and a concrete auxiliary spillway and outfall stilling basin. The dam embankment is approximately 900 feet long, with a maximum height of approximately 37 feet and a dam crest of approximately 15 feet width. The principal spillway consists of a concrete riser inlet structure with a trash rack and a 12-inch diameter low-level drain regulated by a slide gate. The inlet structure and low-level drain discharges into a 42-inch RCP, which conveys flow for approximately 171 feet to the outfall concrete stilling basin and natural Middle Fork Brush Creek channel. The auxiliary spillway consists of an 80- foot-wide concrete channel spillway with vertical sidewalls, discharging into a concrete stilling basin with baffle blocks. The reservoir extends to the north of the dam and primarily includes Rincon Valley Little League Park and adjacent rural residential parcels.

Diversion Structures

Santa Rosa Creek Diversion Structure

Constructed in 1963 as part of the CSWP, the Santa Rosa Creek Diversion Structure is a critical flood protection element that works in tandem with Santa Rosa Creek Reservoir to reduce flooding along Santa Rosa Creek and throughout the City of Santa Rosa. The Diversion Structure consists of a weir, orifice, fish ladder, Vortex Tube (submerged flow-regulating culvert under

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[96] HDR/Kleinfelder Joint Venture. 2016. *Op. cit.*

[97] HDR/Kleinfelder Joint Venture. 2016. *Op. cit*.

Montgomery Drive), and diversion channel that carries diverted high flows to Spring Lake (Santa Rosa Creek Reservoir). During typical flow conditions (up to approximately 500 cfs) Santa Rosa Creek flows south and westerly parallel to Montgomery Drive as it approaches the diversion structure. Flow is backwatered by the diversion weir and directed northerly underneath Montgomery Drive through the 96-inch diameter Vortex Tube before discharging into the Santa Rosa Creek channel. When flows entering the diversion structure exceed approximately 500 cfs the diversion weir is overtopped and a portion of high flows are diverted into a diversion channel leading to Santa Rosa Creek Reservoir where it is temporarily stored and released back into Santa Rosa Creek through the Spring Lake principal spillway. When flows approaching the diversion structure increase to approximately 4,600 cfs, the diversion structure overtops onto Montgomery Drive and begins to reenter the natural channel of Santa Rosa Creek.

The Santa Rosa Creek Diversion Structure includes a reinforced concrete trench (sediment trench) that spans the low-flow channel. The purpose of the structure is to intercept low-flows and sediment and direct them into the Vortex Tube and away from the diversion channel and Santa Rosa Creek Reservoir. The semicircular sediment trench focuses stream flow but results in a potential jump barrier to migrating salmonids. To provide passage opportunities around the sediment trench during typical migration periods the Santa Rosa Creek Diversion structure includes a reinforced concrete fish ladder parallel to Montgomery Drive on the right bank of Santa Rosa Creek. The fish ladder is approximately 6 feet wide and 60 feet long and consists of 7 columns and deflector walls that provide localized quiescent resting areas and open slots for fish passage.

In 2021, Sonoma Water installed a bypass pipe that diverts flows from Santa Rosa Creek and the Vortex Tube to facilitate inspections and maintenance activities of the Vortex Tube. The bypass pipe is located approximately 15 feet upstream of the existing fish ladder, adjacent to the Vortex Tube, and terminates on the north side of Montgomery Drive through a 145-foot earthen swale that connects to Santa Rosa Creek. Although the bypass pipe is a permanent feature, it remains closed under normal operating conditions to maintain the original hydraulic function of the Santa Rosa Diversion Structure.

Spring Creek Diversion Structure

The Spring Creek Diversion diverts flow from Spring Creek to Spring Lake during most flow conditions. As flows approach the diversion structure, an earthen embankment and concrete weir divert flows through a 12-foot-wide by 7-foot-high box culvert that discharges into a diversion channel and ultimately, Santa Rosa Creek Reservoir. A 12-inch pipe, with an inlet located on the diversion channel just downstream of the box culvert outfall, returns a small amount of flow back to Spring Creek. Once flows reach approximately 900 cfs, water overtops the crest of the concrete spillway, and routes higher flows to the natural Spring Creek channel and ultimately, Matanzas Creek.

4.3.5.4 Diversion Facilities at Mirabel and Wohler

As described in the Description of the Proposed Action, Sonoma Water operates and maintains diversion facilities at Mirabel and Wohler, which includes an inflatable dam, fish screens, and a fish ladder to provide passage through the dam. The inflatable dam impounds approximately 5 km of river (Wohler Pool) and is approximately 160 feet wide. With one exception, the entire 5 km of the Wohler Pool has a maximum depth of approximately 11 feet. The one relatively deep section of river (the “Redwood hole”), has a maximum depth of approximately 16 feet, but is relatively small.[98] Pool conditions are likely to diminish the value of this reach as salmonid habitat, by: preventing the establishment of emergent riparian vegetation, reducing the ability of the river to cool at night (in the pond), and potentially improving habitat conditions for known salmonid predators (Pikeminnow and Smallmouth Bass; see additional discussion below). Pools and riffles are also inundated with inflation of the dam, further reducing habitat complexity.

NMFS has previously raised concerns about the effects of the inflatable dam on water quality. Sonoma Water monitoring of DO in the Wohler Pool has found that DO levels typically range from 6.7 mg/l to 9.0 mg/l – slightly lower than DO levels at the upstream control sites. Initial distress symptoms for salmonids occurred at DO levels of 6.0 mg/l – 7.0 mg/l. Low DO levels can negatively affect metabolic function, swimming, and overall survival of salmonids. Small temperature increases above natural warming occur in the Wohler Pool impoundment (upstream of the dam). Chase *et al.* documented an increase of approximately 0.5°C in August.[99] Summer water temperatures upstream of the impounded area are naturally high, and it is likely that poor rearing conditions may occur in this part of the main stem during the hottest part of the summer, regardless of the presence of the Wohler Pool. Small increases in temperature are unlikely to affect smolts, which migrate through the area earlier in the year, but may slightly reduce the quality of rearing habitat during the summer.

Additional discussion on water supply facilities, including diversion facilities at Mirabel and Wohler is provided below (see Section 4.6, *Water Operations Facilities*). Additional discussion on the fish community in Wohler Pool is provided below (see Section 4.9, *Fish Community*).

4.3.5.5 Tributary Habitat Enhancement

A total of ten potential tributary enhancement projects are outlined within the *2008 Biological Opinion*, with the requirement that Sonoma Water implement at least five of these projects by the end of year 3 of the 15-year period covered by the *2008 Biological Opinion*. The five projects Sonoma Water implemented are summarized below.

Grape Creek Habitat Improvement: The Grape Creek Phase 1 portion of the project consisted of installing 8 complex log and boulder structures along a 1,200-foot reach of Grape Creek upstream of the Wine Creek Road Crossing. Implementation of this work took place in July and August of 2009. A total of 248 native trees and shrubs were planted along this reach of the project. Post-construction monitoring of the log structures during high creek flows and riparian plantings documented that the Phase 1 constructed features were performing as intended. The Grape Creek Phase 2 portion of the project consisted of installing 9 complex log and boulder structures and 2 bank layback areas along a 700-foot reach of Grape Creek upstream of the West Dry Creek Road Crossing. Implementation of this work took place over two construction seasons, in 2009 and 2010. Construction began in early October 2009 and was cut short due to rain.

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[98] Chase, S.D., R.C. Benkert, D.J. Manning, and S.K. White. 2005. "Sonoma County Water Agency's Mirabel Rubber Dam/Wohler Pool Fish Sampling Program: Year 5 Results: 2004."

[99] Ibid.

Construction resumed in late August 2010, with heavy equipment work completed in the first week of September, and erosion control completed in early October. The remaining vegetation was installed in early 2011 when the soil was sufficiently moist. Post-construction monitoring of the log structures during high creek flows and riparian plantings documented that the Phase 1 constructed features were performing as intended.

Willow Creek Fish Passage Enhancement Project: Willow Creek is a tributary to the lower Russian River that once supported an abundant subpopulation of Coho Salmon.[100] The creek continues to support significant potential spawning and rearing habitat; however, access to that habitat was partially blocked by impassable road culverts and a shallow braided channel that passes through forested wetland. To implement the Willow Creek Fish Passage Enhancement Project, Sonoma Water partnered with Trout Unlimited on a passage remediation project comprised of culvert removal and new bridge installation. Bridge construction was completed in September 2011. In the winter following completion of the bridge, a marked increase in the number of adult steelhead occurred, as well as a few observations of Coho Salmon jacks. Summer snorkel surveys also indicated an increase in the density of steelhead young-of-the-year. In the second year following construction, a continued increase in the number of adult salmonids and redds were observed, and the first successful spawning of Coho Salmon was documented since 1995.[101] Coho Salmon and steelhead continue to utilize Willow Creek as spawning and rearing habitat.

Crane Creek Fish Passage Project: In October 2011, Sonoma Water implemented the Crane Creek Fish Passage Access Project, consisting of the removal of a partial barrier to fish passage caused by a bedrock outcropping at the lower end of Crane Creek near its confluence with Dry Creek. The project design consisted of creating a series of step pools through the bedrock outcropping to create sufficient depth and flow to allow fish passage. Construction began on October 1, 2011 and was completed on October 18, 2011. Steelhead and Coho Salmon have been observed upstream of the restored step pool feature.

Grape Creek Fish Passage Project: The Grape Creek Fish Passage Project consisted of modifications to a concrete box culvert located where Grape Creek flows under West Dry Creek Road. As part of the permit review and design approval process, NMFS noted that the project design did not meet their maximum allowable 0.5-foot drop height for barrier passage. In October 2010, Sonoma Water proposed re-designing the project to cut into the culvert bottom (instead of placing curbs on top of the culvert bottom) in order to meet the 0.5-foot maximum drop height requirement. Construction of the Grape Creek Fish Passage Project was completed in October 2012. Coho Salmon and steelhead spawning is consistently documented in Grape Creek upstream of the modified concrete box culvert.

Mill Creek Fish Passage Project: In April 2015, NMFS acknowledged that providing funding towards the construction of the Mill Creek Fish Passage Enhancement Project would meet the intent of the RPA requirements and would complete the fifth and final tributary enhancement project. The Mill Creek Project improved Coho Salmon access into 18km of upper Mill Creek

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[100] J. Martini-Lamb and Manning, D.J., editors. 2020. Russian River Biological Opinion Status and Data Report Year 2016. Sonoma County Water Agency, Santa Rosa, CA. 315 p.

[101] Prunuske Chatham, Inc. and CA Sea Grant, 2014. Willow Creek Road 2nd Bridge Area Fish Passage Project. Jenner, Sonoma County, California Final Fisheries Monitoring Report. April 2014.

and was completed in the summer of 2016. PIT tag monitoring at the Mill Creek site demonstrated that adult salmonids successfully navigated the project reach one month after barrier removal and project completion. Additionally, the newly constructed side channel continues to provide lower velocity habitat for juvenile salmonids. Together, the two channels create an array of velocity and depth conditions to accommodate passage for both adults and juveniles over a wide range of flows.[102]

4.3.6 Channel Maintenance Activities

Sonoma Water and the MCRRFC&WCID are the local sponsors responsible for maintaining channel improvements below CVD, in Sonoma and Mendocino counties, respectively, following completion of the project. To facilitate future maintenance work, USACE provided the Channel Improvement Operations and Maintenance (O&M) Manual for the Russian River.[103] This manual is still in use and include procedures for maintaining channel improvements on the Russian River. The Russian River naturally exhibits substantial meandering, erosion, and aggradation. Maintenance of these sites became the responsibility of the local sponsors after construction. The O&M Manual provided by USACE has provided guidelines for inspecting and maintaining the installed improvements on a yearly basis, or as needed before, during, and after flood events.

Sonoma Water and MCRRFC&WCID are responsible for inspecting the approximately 21 channel improvement sites that were constructed by USACE between 1956 and 1963. The sites are located throughout Mendocino and Sonoma counties, extending from river kilometer (rkm) 157.7 near Calpella to approximately rkm 64.3 near Maacama Creek in Healdsburg. Sonoma Water is the local agency responsible for inspecting sites within Sonoma County and the MCRRFC&WCID is responsible for those sites located within Mendocino County. The first of these improvement sites were constructed in a test reach on the Russian River, between rkm 83.7 and 90.1, during October 1956 to February 1957, and formed a basis for observation and determination as to the most effective types of protection for the varied conditions at different locations. This reach was selected because prior to site construction it had been subjected to serious meandering and erosion problems. Channel improvements included clearing, construction of pilot channels, wire mesh-gravel bank revetments, various combinations of single and multiple row jack lines, flexible fence, tree pendants, pervious erosion checks, and willow sprig plantings. Tree pendants and willow sprigs were not used in subsequent work. Channel improvement works, including channel clearing and levee reworking between rkm 90.1 and 101.4 were completed and turned over to Sonoma Water for operation and maintenance in November 1962. During the 1963 construction season, further channel improvements utilizing the methods outlined above were completed between rkm 67.6 to 83.7 and turned over to Sonoma Water and the MCRRFC&WCID.

The *2008 Biological Opinion* included coverage for Sonoma Water and the MCRRFC&WCID to conduct channel maintenance activities in the Russian River and its tributaries to reduce the potential for flooding and erosion. The MCRRFC&WCID performs maintenance activities over

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[102] Prunuske Chatham, Inc. 2017. Mill Creek Fish Passage Monitoring – Post-Construction. Technical Memo. Provided to Mary Ann King & Trout Unlimited. October 30, 2017.

[103] USACE, 1965. Russian River Channel Improvement Operation and Maintenance Manual, Channel Improvements, Russian River, Sonoma County, California, July 1965.

the 58-km reach of the Russian River in Mendocino County from the county line north of Cloverdale upstream along the river north to the town of Calpella. The MCRRFC&WCID is also responsible for any channel maintenance actions in the East Branch of the Russian below CVD downstream to the confluence with the Russian River; a 1.6-km reach. The Sonoma Water maintenance area is a 35-km reach from rkm 66.0 near the confluence of Maacama Creek upstream along the Russian River to rkm 101.4 just north of Cloverdale.

Maintenance actions covered under the *2008 Biological Opinion* actions undertaken by Sonoma Water and MCRRFC&WCID include:

- flood control and bank erosion control in the Mark West Creek watershed;
- flood control and channel maintenance at Central Sonoma Watershed Project facilities (now covered under Sonoma Water's Stream Maintenance Program (SMP), see *Stream Maintenance Program*);
- activities related to CVD and WSD;
- streambank erosion control in the Russian River; and
- emergency actions in natural channels.

These maintenance actions were comprised of sediment management, channel debris clearing, vegetation maintenance, and bank stabilization. Additionally, small amounts of top-of-bank landscape and structure maintenance, and storm-drain outfall maintenance were performed.

Stream Maintenance Program

The *2008 Biological Opinion* also provided incidental take coverage for maintenance activities performed under the Stream Maintenance Program (SMP) for Flood Management Zones 1A (Laguna de Santa Rosa – Mark West Creek Watershed), 4A (Upper Russian River Watershed), and 5A (Lower Russian River Watershed) within certain natural channels, modified channels, and constructed flood control channels.[104] SMP channel maintenance was conducted as a cooperative effort between Sonoma Water maintenance staff and biologists to achieve both flood control and aquatic and riparian habitat objectives. The SMP now has a separate NMFS Biological Opinion and has independent utility; as such these maintenance activities will not be evaluated in this Biological Assessment.[105]

Historical Maintenance Actions

Prior to the issuance of the *2008 Biological Opinion*, typical maintenance activities for channel improvement sites in the mainstem Russian River included removing loose anchor jacks from the river, repairing and replacing loose grout or riprap, adding bank erosion protection at sites found to be eroding, and managing vegetation and removing flood debris to reduce blockage of the river channel that is causing bank erosion or preventing inspection of channel improvement sites.

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[104] Flood Management Zones follow the ridge crests that delineate major watersheds within Sonoma County and include coastal and San Francisco Bay tributary streams in addition to tributaries of the Russian River.

[105] SCWA, 2021. Biological Assessment for Anadromous Fish Species, Sonoma Water Stream Maintenance Program. Prepared by January 7, 2021.

Bank stabilization activities by Sonoma Water and MCRRFC&WCID on the Russian River and its tributaries are limited to maintenance of past channel improvement projects, several of which were implemented by USACE on the Russian River to prevent streambank erosion following construction of CVD, and for which Sonoma Water and MCRRFC&WCID are the local sponsoring agencies responsible for maintenance. Examples of bank stabilization structures previously installed as part of the Russian River Channel Improvement Project and maintained, as necessary, include anchored steel jacks in single and multiple rows, flexible fence training structures, wire mesh and gravel revetments (i.e., retaining wall), and pervious erosion check dams. Anchored steel jacks, used in bank protection, are utilized to prevent streambanks from undercutting. The jacks are ¼-inch angle iron with 16-foot legs, cabled together and anchored to the streambank on the ends. Previous erosion check dams consist of gravel and wire mesh and are used to control sheet erosion on streambanks. Many of the channel improvements described above were implemented to prevent erosion and provide bank stabilization. Many have been covered with soil, brush, and trees, and continue to provide the protection they were designed for with little or no maintenance needed.

The channel improvement areas and levees are inspected periodically by Sonoma Water, and USACE. USACE then recommends maintenance work that may be needed. If a need for repairs is identified, those repairs are implemented and described in the annual reports to USACE. Typical maintenance recommendations for the channel improvement sites have included removing loose anchor jacks from the river, adding bank erosion protection, managing vegetation to reduce blockage of the river channel and increase access for maintenance and inspection of the banks, repairing or replacing loose grout or riprap, and removing driftwood.

4.3.7 Russian River Estuary

The Russian River Estuary (Estuary) extends from the mouth of the Russian River upstream approximately 11 km to between the communities of Duncans Mills and Austin Creek. Periodically, a barrier beach forms and closes the inlet between the Estuary and the Pacific Ocean. This closure causes the Estuary to switch from tidally fluctuating water levels to slowly rising water levels from river inflows and wave overwash creating a backwater lagoon to Monte Rio and as far upstream as Vacation Beach.[106] The salinity in the Estuary is a mixture of tidal seawater and freshwater river flows. Closed mouth conditions restrict tidal exchange and limit salinity contribution to wave overwash and, typically, increase the depth of the freshwater lens in the Estuary and shifts brackish water upstream to as far as Brown's Riffle near Austin Creek.

The Estuary is a bar-built estuary, meaning that its behavior is heavily influenced by the characteristics of the barrier beach (bar) that periodically forms and closes the river mouth.[107] Though closure happens most often during the fall when long-period ocean swell waves can deposit more sand in the inlet than tidal and riverine flow can scour, it can occur in any month of the year. At times of stronger wave conditions or weak river discharge conditions, sand

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[106] Environmental Science Associates, 2010. Russian River Estuary Management Project – Draft Environmental Impact Report. Prepared for Sonoma County Water Agency. December 2010.

[107] Behrens, D., F. Bombardelli, J. Largier, and E. Twohy, 2013. Episodic closure of the tidal inlet at the mouth of the Russian River – A small bay-built estuary in California. Geomorphology 189 (2013): 66-80.

deposition into the tidal inlet may completely block the inlet, creating a continuous barrier beach that separates the ocean from the Estuary. This 'closure' of the inlet alters the characteristics of the Estuary over the subsequent days and weeks, shifting conditions from colder and well-mixed vertically to a water body with vertical layers of differing salinity, temperature, and dissolved oxygen. When water quality conditions in the Estuary are otherwise favorable, these 'lagoon' conditions can at times provide valuable rearing habitat for juvenile salmonids during the late spring into summer months when closures coincide with juvenile steelhead rearing.[108] This behavior is common for the majority of smaller estuaries in California, as well as a number of sites in Oregon.[109,110] During inlet closures, flow from these estuaries may spill in one direction over the beach without eroding a tidal inlet. This is referred to as 'outlet channel' or 'perched outlet channel' conditions. At the Russian River, this is a rare event, occurring only as a transitional state immediately before closure or full inlet breaching.[111]

Prior to the issuance of the *2008 Biological Opinion*, estuary management focused on minimizing flood risk through artificial breaching of the barrier beach. Studies of other northern California estuaries have documented linkages between tidal inlet closure and the improved value of the resulting lagoon condition for juvenile steelhead rearing habitat.[112,113] In recent decades, the use of artificial breaching for mitigating flood risk has declined in California, largely due to permitting requirements targeted toward preserving valuable salmonid rearing habitat in closed lagoons.

Artificial breaching of the barrier beach that periodically forms at the mouth of the Russian River has been documented since the early 1900s. Residents would initiate artificial breaching by digging a channel across the beach with shovels to prevent land along the Estuary from flooding. From the 1960s to the early 1990s, breaching was performed more regularly by Sonoma County.[114] Starting in the mid-1990s, artificial breaching was performed by Sonoma Water, in accordance with the *Russian River Estuary Study 1992-1993*.[115] The guidance provided by the study called for breaching following a river mouth closure when the water surface elevation in the Estuary was between 4.5 and 7.0 feet above the National Geodetic Vertical Datum of 1929 (NGVD29), as read at the Jenner gage located at the Jenner Visitors' Center. This was intended to be a compromise between limiting flooding in Jenner, while also

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[108] Boughton, D., J. Fuller, G. Horton, E. Larson, W. Matsubu, and C. Simenstad. 2017. Spatial Structure of Water Quality Impacts and Foraging Opportunities for Steelhead in the Russian River Estuary: An Energetics Perspective. NOAA-Technical Memorandum-NMFS-SWFSC-569.

[109] Heady, W.N., R.P. Clark, K. O'Connor, C. Clark, C. Endris, S. Ryan, S. Stoner-Duncan, 2015. Assessing California's Bar-Built Estuaries using the California Rapid Assessment Method. Ecological Indicators, Vol. 58, p. 300-310.

[110] Clark, R. and K. O'Connor, 2019. A Systematic Survey of Bar-Built Estuaries along the California Coast. Estuarine, Coastal and Shelf Science. Vol. 226.

[111] Environmental Science Associates (ESA). 2021b. Russian River Estuary Habitat Focus Area Phase 2: Habitat Enhancement Opportunities. Prepared for Sonoma County Water Agency. October, 2021. 15 p.

[112] Bond, M.H. 2006. Importance of Estuarine Rearing to Central California steelhead (*Oncorhynchus mykiss*) growth and marine survival. M.A. Thesis. University of California, Santa Cruz.

[113] Bond, M.H. 2006. *Op. Cit.*

[114] Schrad, J. 1992. History of Opening and the Russian River and Salmon Creek. Department of Public Works, Road Maintenance Division.

[115] Heckel, M. 1994. Russian River Estuary Study, 1992-1993. Prepared for Sonoma County Department of Planning and California State Coastal Conservancy.

reducing the risk of low dissolved oxygen water forming in Willow Creek Marsh (due to natural biochemical oxygen demand within the marsh during periods of high water levels). It was thought that low dissolved oxygen water would be released from the marsh into the Estuary during subsequent breach events, creating a threat for fish kills. The *2008 Biological Opinion* required modifying breaching activities to minimize flood risk by managing Estuary conditions to enhance rearing habitat for juvenile salmonids, specifically steelhead, from May 15 to October 15 (referenced as the “lagoon management season”), and has continued to evolve as part of the adaptive management process (Section 3.5.1.3, *Adaptive Management Plan: Proposed Action*).

Monitoring data collected since 2009 in the Estuary and on the barrier beach have generated a wealth of information on the beach and river mouth morphology, and the resulting hydrology, water quality, physical processes, and habitat conditions in the Estuary. This was a planned outcome of the *2008 Biological Opinion*, which called for a series of incremental steps to adaptively manage the Estuary, as new information is obtained. In addition to monitoring, a series of studies designed to improve understanding of the physical processes in the Estuary and to identify routes for improving management were completed. Specifically, the *2008 Biological Opinion* RPA calls for Sonoma Water to conduct “adaptive management of the outlet channel, investigation and possible elimination of impacts of the jetty at the river’s mouth on lagoon formation, and alternative approaches to flood risk reduction (e.g., elevating structures or other methods)” (p. xvii). This review of baseline conditions considers both the original guidance from the *2008 Biological Opinion* and the findings of the monitoring and studies conducted since its issuance. This review also compares observations of Estuary conditions both before and after implementation of the *2008 Biological Opinion*, to assess for changes in the Estuary in response to management. Sonoma Water also engaged in studies that were not specifically identified in the *2008 Biological Opinion*, including studies of the physical processes that drive beach morphology, and circulation and water quality in the Estuary.

4.3.7.1 Inlet States

The condition of the tidal inlet (river mouth) is a key factor underpinning hydrologic conditions within the Russian River Estuary. The inlet consists of a channel connecting the Estuary to the ocean through the beach berm; whose shape and location relative to the Jetty influences the tide range in the Estuary, primarily via the depth and exposure of the channel relative to oceanic tides. The channel is constantly changing shape as waves push sand into the inlet while competing erosive tidal flows and river discharge scour sand out of the inlet.

The inlet is deeper when river flows are high, when ocean tide ranges are greatest (e.g., periods of ‘spring tides’), and when ocean waves are small. A deeper channel gives rise to ‘wide open’ conditions. This deep inlet condition occurs when the tide range in the Estuary is relatively large and similar to the ocean tide range. Active tidal mixing reintroduces cold oceanic water twice per day, creating higher dissolved oxygen (DO), lower water temperature, and increasingly saline water quality. Open inlet conditions are the most common in the Estuary, and occur throughout most of winter, spring, and summer (See Section 4.4.5.5, *Comparison with Other Estuaries*).

‘Muted open’ conditions occur when waves are able to fill the inlet enough to cut off a substantial portion of flow during low tides. When this occurs, tidal mixing still occurs in the Estuary during mid or high tides, but the Estuary is unable to drain fully at low tide. This gives rise to warmer temperature, decreased salinity, and lower DO conditions.

If the inlet continues to fill with sand, the Estuary can continue to spill out toward the ocean, but incoming tides are not able to enter the Estuary. This ‘outlet channel’ or ‘perched’ condition requires strong waves or weak outflows to persist, otherwise the outflow tends to scour the bed and enlarge the inlet, restoring open or muted conditions. The loss of tidal motions enhances the trends in water quality conditions observed during ‘muted open’ conditions. Both the ‘muted open’ and ‘outlet channel’ cases are typically transitional states prior to the last type of inlet state, which is the ‘closed’ inlet. The terms ‘outlet channel’ and ‘perched’ are commonly used to describe lagoons whose average water surface elevations are above ocean tide levels and maintain unidirectional flow from the Estuary to the ocean. In this report, the term ‘outlet channel’ is used to infer unidirectional flow conditions. In some systems, ‘perched’ can include lagoons that experience two-way flows in the mouth, but with average levels well above average ocean tides. This condition has been observed for extended periods in smaller systems, including Scott Creek and Carmel River estuaries.[116] This condition has also been observed at the Russian River for brief (less than two weeks) periods of time, always as an ephemeral state before full closure or breaching.[117]

A river mouth closure occurs when waves deposit enough sand on the beach berm and within the inlet to fully block surface water exchange into or out of the Estuary. Closure conditions are most frequent in the spring and fall months, when waves are energetic and river flow is lower, making it less likely for river flow to fill the Estuary and erode a new inlet. Closure conditions are the second most common scenario, with ‘wide open’ conditions being the most frequent. Closed conditions are associated with vertically salt-stratified conditions in the Estuary; where lower saline waters tend to have lower oxygen, and the fresher layer on top provides most of the available salmonid habitat if water temperatures are suitable.[118]

Once the inlet is closed, the duration of closure depends on the height of the beach berm, and the rate at which river flow fills the Estuary. Once the river flow fills the Estuary to a level where it can spill over the lowest point in the beach, this spilling flow usually erodes a new inlet, causing a return to open conditions. This erosion of the beach berm by rising estuarine water levels is referred to as ‘self-breaching.’ Since river discharge and ocean waves vary seasonally throughout the year, prolonged (one or more weeks) inlet closure events tend to occur when river discharge is low and waves are powerful enough to induce closure. Erosion of inlet closure can occur rapidly (hours or days) or occur slowly over weeks.

4.3.7.2 Seasonal Behavior

The Russian River Estuary is a bi-modal system; based on data obtained from 2000 to 2021, it is most often wide open (66 percent (%) of the year) or closed (24%). Muted open (8%) and outlet

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[116] Bond, M.H. 2006. *Op. cit.*

[117] ESA. 2021b. *Op. cit.*

[118] ESA. 2021b. *Op. cit.*

channel (2%) conditions are rare and tend to be transitions from open to closed states. Closures are more likely in late summer and fall, when wave energy increases from its mid-summer minimum and discharge remains low. Outlet channel conditions occur more often in summer than fall.[119]

The bi-modal nature of the Estuary is similar to other estuaries in central and northern California with seasonally high flows and high waves, such as Pescadero Creek or the Pajaro River. Sites with either less exposure to powerful waves or smaller watersheds tend to have a more distributed range of conditions. Examples include Scott Creek or Rodeo Lagoon, where perched or outlet channel conditions can be persistent for several months.

Historically, the Russian River's inlet closure events have occurred in all months of the year, but tend to be most common in spring and fall months.[120] Spring closures tend to be short (one to two weeks in duration) and fall closures tend to last longer; owing to lower river discharge in the fall. In relatively wet years, inlet closures still occur but typically do not last for more than one or two weeks at a time since high flows rapidly fill the Estuary and erode a new inlet. In dry years, the slower rate of inflow allows for longer closure events. **Figure 4-3** demonstrates this pattern by showing Estuary water levels and closure events, river discharge, and nearshore wave power (calculated from wave height and period, wave power is a surrogate for sand deposition due to wave action) for the period from 2000 to 2020. The higher likelihood of closure conditions in fall is due to higher and more energetic waves and lower river discharge. Waves with greater height and longer period (longer wave length) are more energetic, and are more capable of pushing sand onshore to build the beach and fill the inlet channel with sand. Flows tend to be low until the first rainfall events in November, whereas larger swell wave events tend to begin in September. When closure events occur in late spring or early summer, the higher river flows tend to fill the Estuary to the level of the beach more rapidly, often ending with a self-breach. In contrast, low river discharge in fall is more likely to allow closure events to last for many weeks at a time.

Since muted or outlet channel conditions tend to be transitional states,[121] it can be helpful to identify the ways that these events end. During relatively high flow conditions, these states usually end by transitioning into a wide-open state when the high river discharge coincides with a low tide. This tends to happen in early to mid-summer, when river discharge is typically higher, and waves are lowest. Spring tides (periods of time with the greatest tide range, occurring about every two weeks) are associated with the most erosion at low tide, so outlet channel or muted conditions tend to dissipate during spring tide periods. During low flow conditions, transitions to wide open conditions can still occur during spring tides. However, the more common transition from muted or outlet conditions is closure, when waves push sand into the mouth.

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[119] Behrens, D.K. 2021b. *Op. cit.*

[120] Behrens, D.K. 2012. The Russian River Estuary: Inlet Morphology, Management, and Estuarine Scalar Field Response. University of California, Davis.

[121] ESA. 2023. Russian River Estuary Adaptive Beach Management Plan. Prepared for Sonoma County Water Agency by ESA with Bodega Marine Laboratory, University of California at Davis. May 23, 2023.

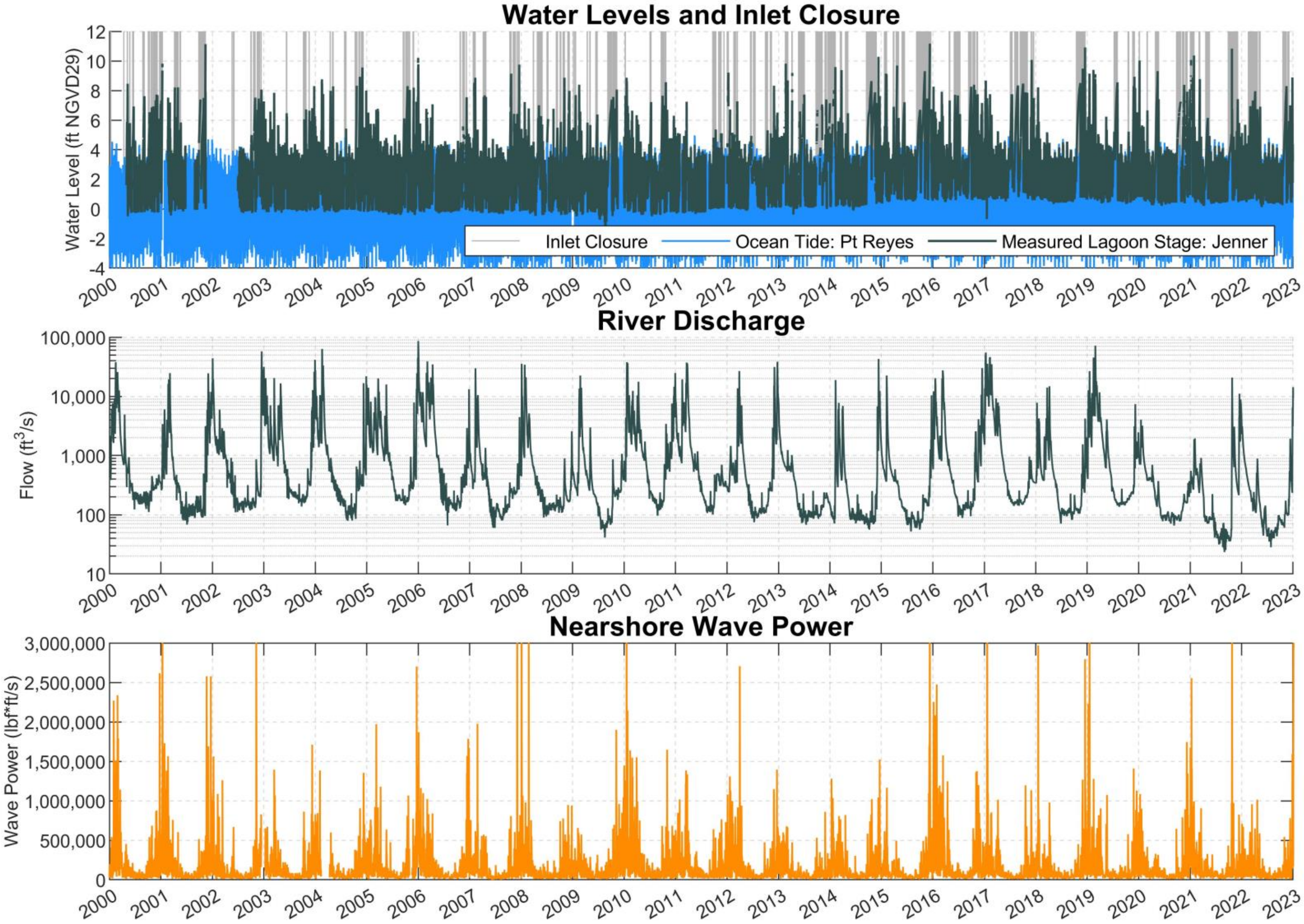
4.3.7.3 Interannual Behavior

Taking a long-term view, inlet closure also varies sharply from year to year in response to variations in rainfall. **Figure 4-4** demonstrates this by showing time series of average annual flow rate versus the number days of inlet closure observed from 1976 to 2022. A roughly decadal pattern is apparent: in the relatively wet early 1980s and from 1996 to 2006, the inlet was closed for fewer days per year than average. Conversely, inlet closure was more frequent in the drier early 1990s, and for much of the 2010s from multi-year drought conditions.

4.3.7.4 Comparisons of Conditions Before and After 2010

Figure 4-5 summarizes seasonal conditions for the decade preceding (2000-2010) and for the decade after 2010 (2010-2022). This plot condenses the observations for river discharge, water surface elevations, and inlet closure into a representative 'year' by showing the average or range of data for each day of the year for each decade. This gives an indication of how similar or different average conditions were between the two decades. The figure does not show ocean tides or wave conditions, which were roughly the same across time periods.

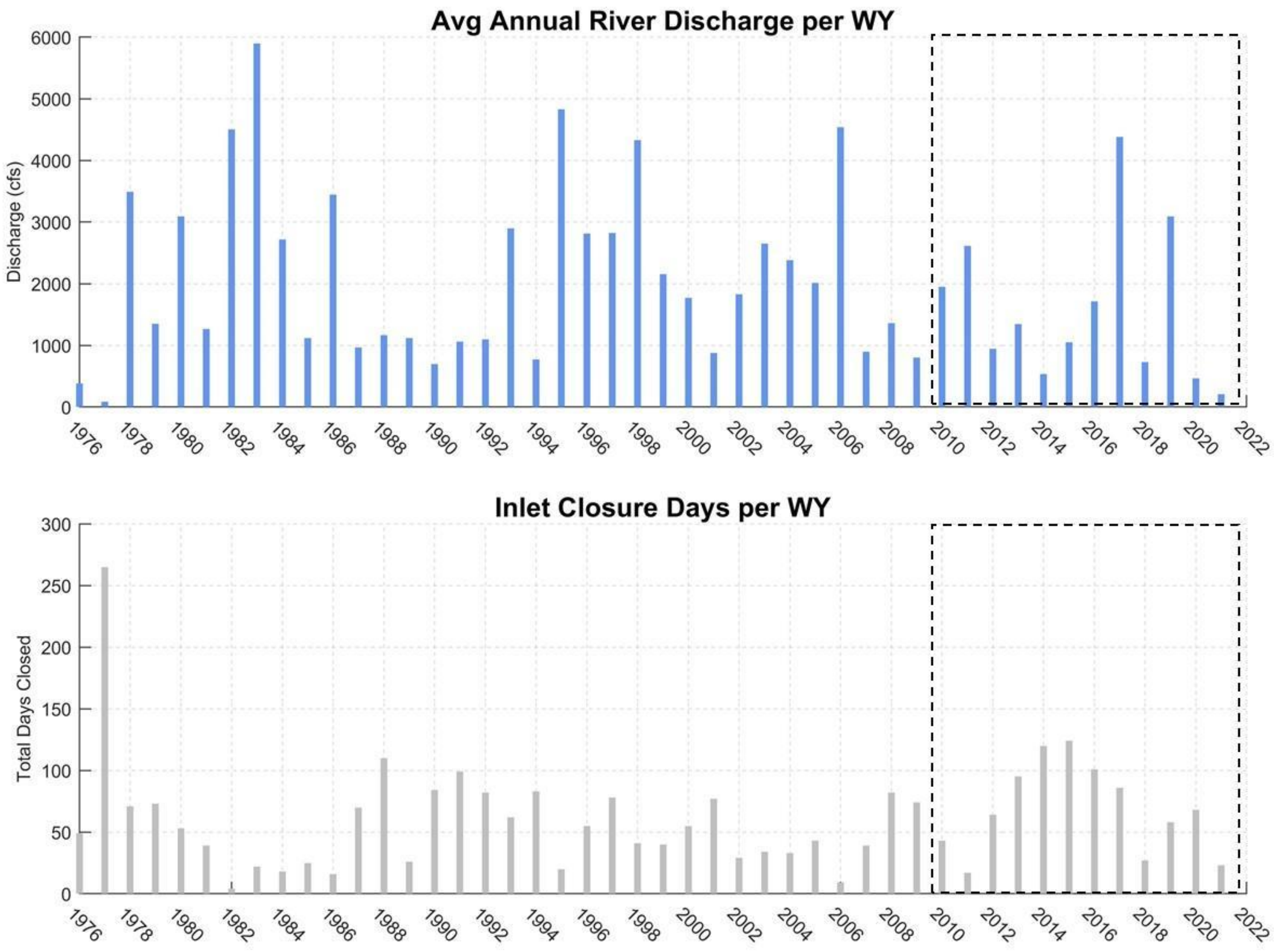
Overall, the seasonal patterns in river discharge, Estuary water level, and daily river mouth closure percentage are similar for the decade preceding 2010 and the decade after 2010, although there are slight differences in parameter ranges between these two decades. The primary difference before and after 2010 are seasonal flows during the dry months from May to October. These were lower on average in recent years, even after including wet conditions in 2011, 2012, 2017, and 2019. Lower river discharge allowed closure events to last longer than in prior years, as well as more recent changes in management, allowing for closures to persist for longer (Figure 45 lower panel). This in turn led to higher average water levels (Figure 4-5 middle panel). Outlet channel conditions were rare both before and after implementation of the *2008 Biological Opinion*, despite changes in beach management. They tended to occur as ephemeral events (lasting several days), during periods of low river discharge and moderate wave conditions, and typically ended with erosion of the inlet or closure. For natural outlet channel conditions to occur, the inlet needs to fill with sediment above the level of ocean tides, but without fully blocking spill of outflows from the Estuary. This tended to be a rare condition in the Russian River because waves are typically powerful enough to fully block these outflows. In the rare condition that waves become less powerful after beginning to close the mouth, flows exiting the Estuary are typically too high to allow the inlet bed to remain high (i.e. exiting flows induce erosion of the bed). Hence, this condition is rare because it requires multiple events to occur in sequence, each of which are unlikely to occur for long periods of time.



SOURCE: Ocean Tide: NOAA Pt Reyes tide station; Estuary tide and closure: Sonoma Water; River discharge: USGS Hacienda Bridge Gage; Nearshore wave power: CDIP

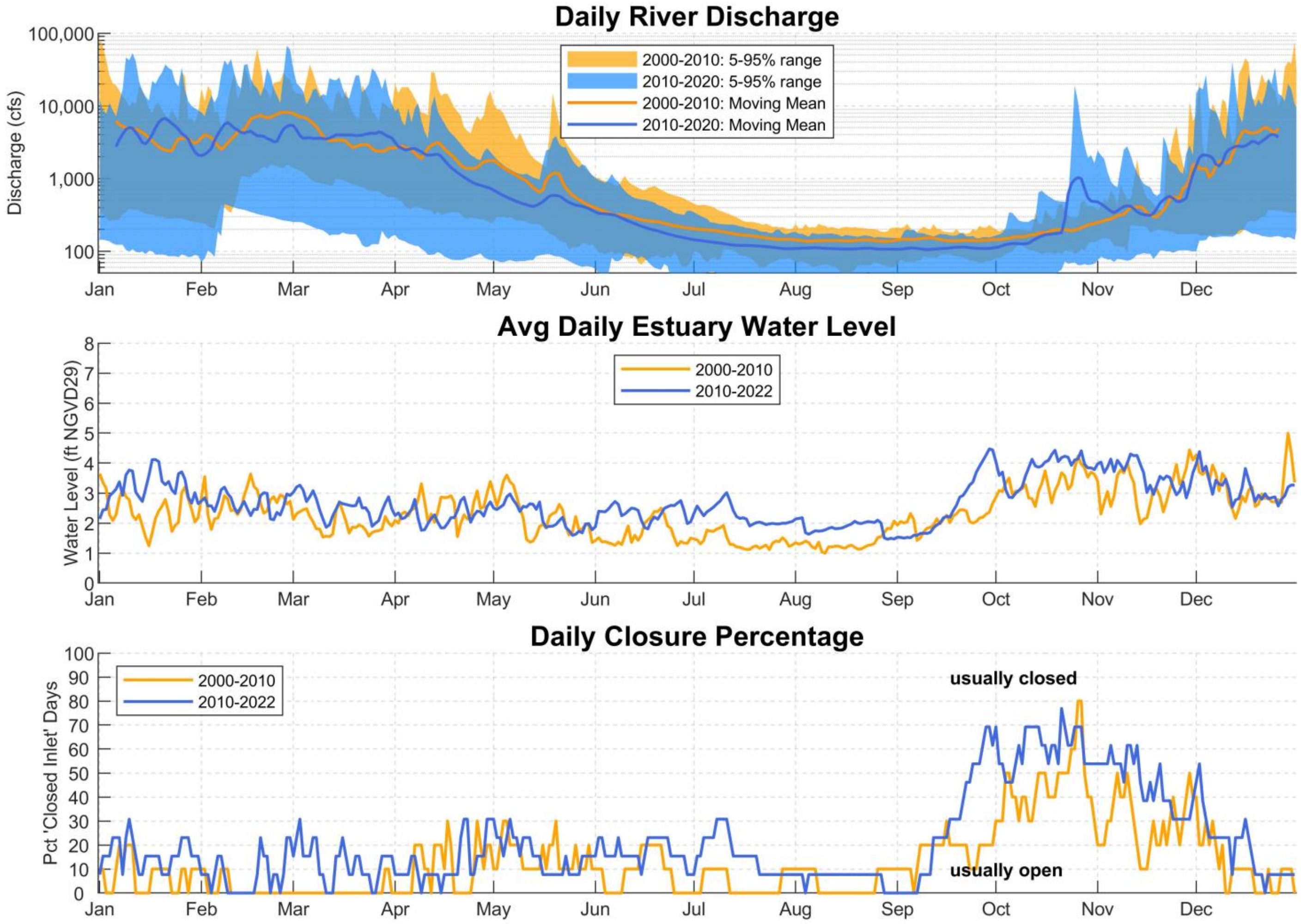
Figure 4-3

Russian River water levels, inlet closure, river discharge, and nearshore wave power from 2000 to 2022



SOURCE: River discharge: USGS Hacienda Bridge Gage; Closure Record: Behrens (2012) and Sonoma Water

Figure 4-4
Annual average river discharge vs. inlet closure from 1976 to 2022



SOURCE: Discharge: USGS Hacienda Bridge Gage; Water level: Sonoma Water; Inlet closure: Sonoma Water

Figure 4-5
Comparison of 2000-2009 and 2010-2022 seasonal river discharge, water levels and inlet closure in the Russian River

4.3.7.5 Comparison with Other Estuaries

The *2008 Biological Opinion* drew from observations in other bar-built estuaries, highlighting the Carmel River and Scott Creek in particular. Both systems support steelhead populations and experience seasonal closures. They also exhibit natural outlet channel conditions for extended periods of time. However, as described below, these two estuaries are closed more frequently than the Russian River Estuary, both at daily and seasonal time frames. More frequent closure is probably due to smaller watershed size, lesser riverine discharge, reduced wave action, and smaller estuarine volume in these two estuaries as compared to the Russian River Estuary.[122]

The Carmel River in Monterey County is about 15% the size of the Russian River watershed. **Figure 4-6** illustrates the seasonality of inlet behavior from 2006 to 2016 in response to environmental conditions. The inlet is less exposed to powerful waves than the Russian River due to its location within an embayment. In comparison, the Russian River mouth is exposed to the open ocean and receives northwest, west, and south swells. The Carmel River has a much smaller river discharge owing to its smaller watershed and more southerly location in the state. As such, dry season flows sometimes fall below 1 cfs. Closure events tend to occur during the dry season, beginning in spring and lasting until the first major rainfall event of the fall. In especially dry conditions such as 2013 and 2014, the inlet may remain closed for more than one year. Open inlet conditions occur only during wet conditions, and even when the inlet is open the ability of the river to scour a deep inlet is limited. The inlet's bed elevation is normally located above ocean high tide elevations, so water only spills in a one-way direction from the Estuary toward the ocean.[123] The inlet is not typically breached artificially except in rare occasions that water levels reach emergency stages, threatening nearby homes on the north side of the lagoon.[124]

Scott Creek is a small coastal creek in Santa Cruz County, with a watershed about 5% the size of the Russian River. **Figure 4-7** shows conditions in the creek from 2010 to 2017. The site has a similar level of exposure to waves as the Carmel River due to partial shielding from a rocky reef on the north end of the beach. Scott Creek's discharge is similarly flashy, typically falling to less

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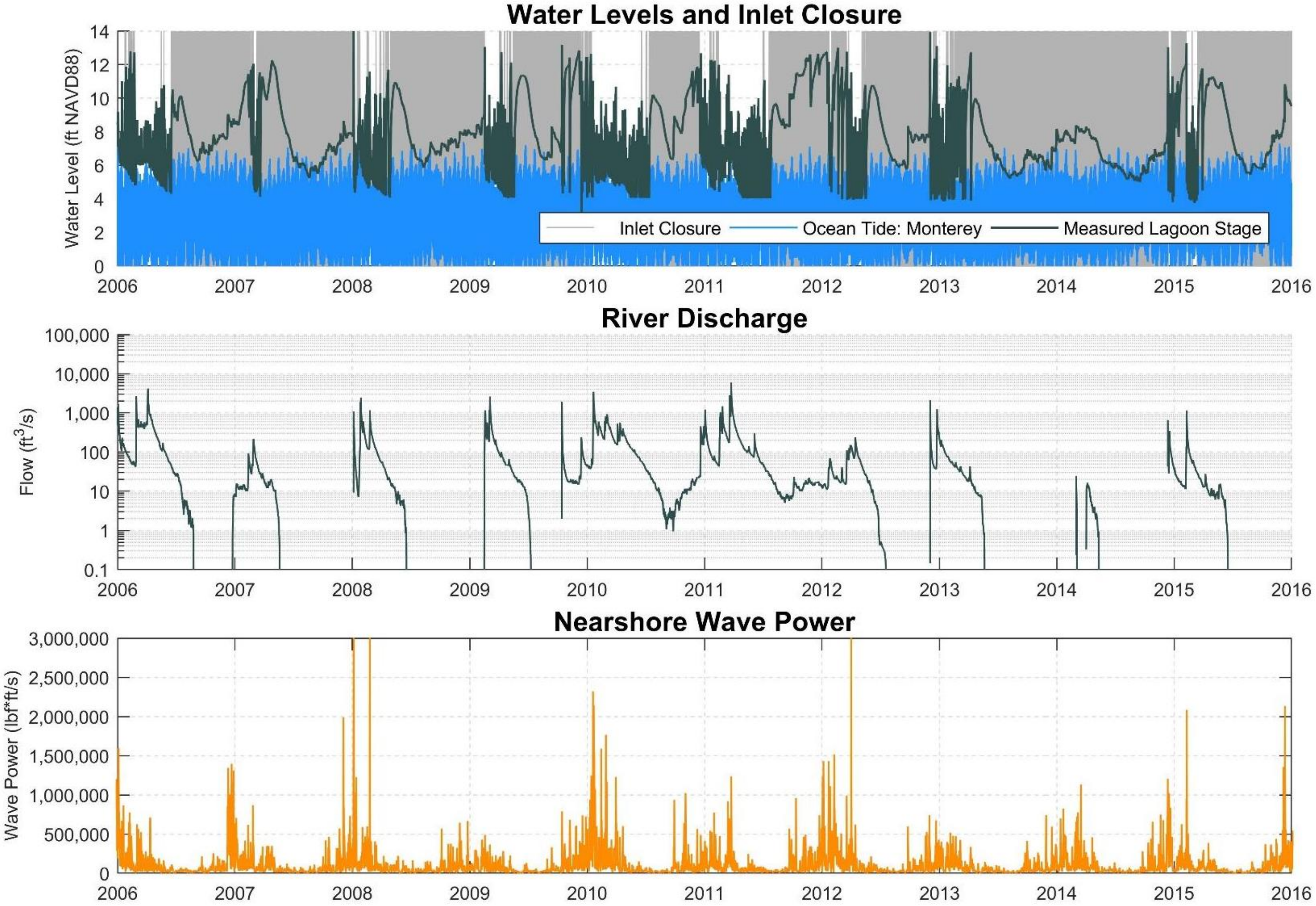
[122] The Russian River watershed drains an area of approximately 3,846 square km, including much of Sonoma and Mendocino counties.

[123] Orescanin, M.M. and J. Scooler. Observations of episodic breaching and closure at an ephemeral river. Continental Shelf Research 166(2018): 77-82.

[124] James, G. 2005. Surface water dynamics at the Carmel Lagoon water years 1991 through 2005. Monterey Peninsula Water Management Agency, Monterey, CA.

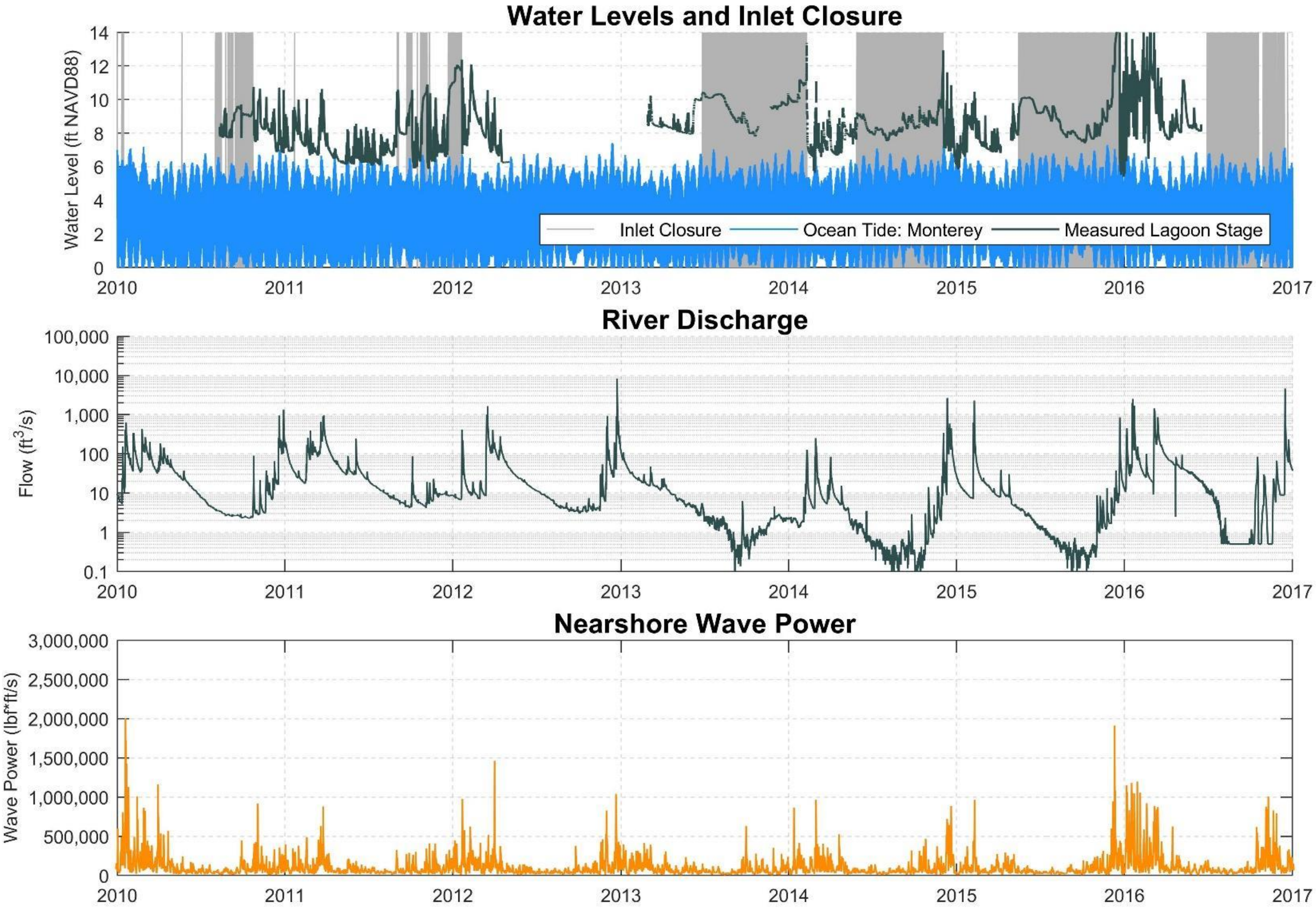

Water Levels and Inlet Closure

River Discharge

Nearshore Wave Power

SOURCE: Ocean Tide: NOAA Monterey tide station; Estuary tide and closure: ESA (2018); River discharge: USGS Carmel River gage (#11143250); Nearshore wave power: CDIP
NOTE: The vertical datum for tides in this plot is NAVD88. Please note that the vertical datum used for the Russian River (plots 5-3 and 5-5) use the NGVD29 vertical datum, which lowers the relative tide value by 2.73 feet.

Figure 4-6
Carmel River water levels, inlet closure, river discharge, and nearshore wave power from 2006 to 2016



SOURCE: Ocean Tide: NOAA Monterey tide station; Estuary tide and closure: ESA (2020); River discharge: ESA (2020); Nearshore wave power: CDIP
NOTE: The vertical datum for tides in this plot is NAVD88. Please note that the vertical datum used for the Russian River (plots 5-3 and 5-5) use the NGVD29 vertical datum, which lowers the relative tide value by 2.73 feet.

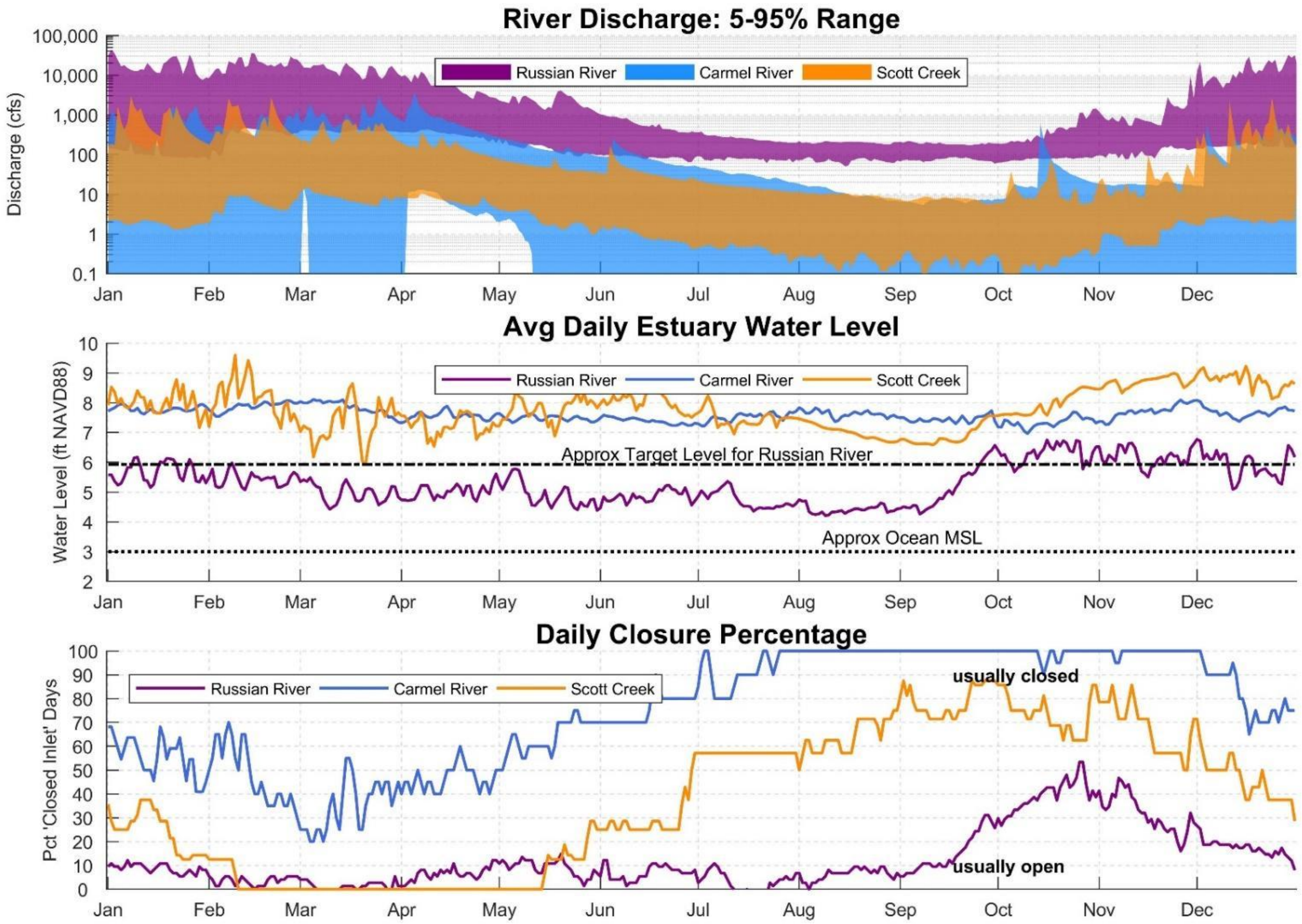
Figure 4-7
Scott Creek water levels, inlet closure, river discharge, and nearshore wave power from 2010 to 2017

than 3 cfs during summer and fall. Like the Carmel River, the inlet is closed seasonally during dry months, and when open to the ocean, the inlet is typically dominated by outflows from the creek to the ocean. Estuary water levels are usually perched above ocean tides. An important difference between Scott Creek and the Carmel River is that the former has a much smaller lagoon volume, so it takes less river discharge to fill the lagoon and spill over the beach. This is likely the reason that Scott Creek was open more frequently than the Carmel River from 2010 to 2017. The mouth of Scott Creek is not managed, since manmade infrastructure is not present within the lagoon. Artificial breaching may occur periodically from beachgoers, as the site is heavily used by the public in summer months.

Figure 4-8 compares conditions between the Russian River, Carmel River, and Scott Creek. Wave conditions are not shown, but vary among the sites to a much smaller degree than river discharge, which is several orders of magnitude lower for the latter two in the dry months. Both the Carmel River and Scott Creek have seasonal water levels (water surface elevations) that are elevated several feet above ocean tides. In contrast, average water levels in the Russian River are only slightly elevated above ocean mean sea level and are closely tied to the likelihood of inlet closure. Water levels at the Russian River tend to be lowest in summer, when the inlet is most frequently open, and highest in fall. Despite the tendency of both the Carmel River and Scott Creek to experience natural outlet channel conditions, inlet closure is significantly more prevalent at these two smaller estuaries. Outlet channel conditions occur as a transitional state at all three sites. In other words, an outlet channel only occurs for a brief period (hours or days) as the mouth changes to open or closed.

While the similarities between the Russian River, Scott Creek, and Carmel River estuaries described above are useful in understanding the relationship between outlet channel conditions and water quality, differences in climate between the three estuaries strongly influence the relative suitability of summer salmonid rearing habitat. For example, both the Scott Creek and Carmel River watersheds are significantly smaller than the Russian River, and include a much higher proportion of high gradient stream channels covered with extensive riparian canopy. This allows for relatively cooler water to enter the estuaries, compared to the Russian River, a watershed which has a much lower gradient riverbed conditions and higher exposure to solar radiation (less shading). In addition, the Russian River watershed extends far inland where summer temperatures often exceed 100 degrees, while the other two watersheds are contained within the cool coastal fog environment.

A number of similar bar-built estuaries exist further north in Oregon. Coastal Oregon has more annual rainfall and higher tide ranges than central and northern California, similar wave conditions, and a number of productive and well-studied salmon runs with ongoing or planned conservation and restoration efforts. These systems typically have smaller watersheds than the Russian River, but experience similar tidal conditions in the Estuary and some have seasonally high river discharge that can be similar in magnitude to that of the Russian River. While many of the estuaries in Oregon have jettied inlets to maintain permanent open conditions, there are five



SOURCE: Ocean Tide: NOAA Monterey tide station; Estuary tide and closure: ESA (2020); River discharge: ESA (2020); Nearshore wave power: CDIP

Figure 4-8
Comparison of seasonal river discharge, estuary water surface level, and inlet closure for Russian River, Carmel River, and Scott Creek

estuaries listed as ‘natural’ by the Oregon Coastal Management Program: from north to south, this includes the Sand Lake Estuary, Salmon River, Sixes River, Elk River, and Pistol River.[125] The southernmost three sites experience periods of inlet closure in dry years. The inlets of these systems are not artificially breached.

The Salmon River, north of Lincoln City, Oregon, has a 194 km^2 watershed, and remains open to the ocean permanently due to partial shielding from ocean swells by the adjacent Cascade Head geologic formation. Within the estuary, the main river channel is flanked on either side by 1,000-2,000 feet of formerly diked agricultural lands that have been reconnected to the estuary as part of long-term restoration efforts. The site has about 230 acres of emergent wetland, taking up a larger proportion of the total estuary area than emergent wetlands within the Russian River Estuary.[126] The Salmon River estuary supports Coho, Chinook, and steelhead, and is monitored by the Sea Grant program at Oregon State University, U.S. Forest Service, and NMFS.

The Sixes and Elk Rivers are both located near Cape Blanco in Curry County, Oregon. Both sites support Coho, Chinook, and steelhead.[127] Unlike the Salmon River, both sites experience occasional inlet closure events in summer or fall months. Closure records are not readily available, but satellite imagery after 2017 indicates closure conditions have occurred in similar months at both sites in recent years. Satellite images also indicate that the inlet in each system is prone to migration, especially at the Elk River, where the inlet tends to migrate northward along the beach for several thousand feet.

The Sixes River has a 334 km^2 watershed and most of the 330-acre estuary is located within 1.6 km of the mouth, although the head of tides extends 6.4 km upstream. The Elk River has a 243 km^2 watershed and 290-acre estuary, with a significant portion made up of the back-beach portion of the estuary. The Oregon Watershed Enhancement Board (OWEB) has awarded grant funding in 2022 to the Curry Watersheds Partnership (CWP) for riparian restoration in the Elk River watershed and habitat restoration design in the lower Sixes River. Planned restoration activities include floodplain reconnection, wetland creation, restoration of the riparian zone, and LWM placement.[128]

4.3.7.6 Beach Management

The importance of beach management is reflected in RPA Element 2: *Alternatives to Estuary Management.* Several of the RPA Proposed Action, including *Management of Estuarine Water Surface Elevations* and *Investigation of Jetty Impacts on Permeability and Lagoon Formation*, call for maximizing freshwater habitat for juvenile steelhead in the lagoon through beach management

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[125] Oregon Department of Fish and Wildlife. 2016. Oregon Conservation Strategy. https://oregonconservationstrategy.org/overview/. Date accessed: August 9, 2023.

[126] Brophy, L.S. 2019. Comparing historical losses of forested, scrub-shrub, and emergent tidal wetlands on the Oregon coast, USA: A paradigm shift for estuary restoration and conservation.

[127] Brophy, L.S. 2003. Wetland Site Prioritization, Lower Elk and Sixes Rivers, Curry County, Oregon. Produced for Oregon Trout.

[128] Wild Salmon Center. 2019. Elk River Strategic Action Plan for Coho Salmon Recovery. https://wildsalmoncenter.org/resources/elk-river-sap-for-coho-salmon-recovery/. Date accessed: August 9, 2023.

practices. This is drawn in part from a review of historical conditions on the Russian River, and review of a number of estuarine reference sites, including Scott Creek and the Carmel River.

The *2008 Biological Opinion* RPA included an adaptive approach to estuary management through the preparation of annual adaptive management plans. In recent years, beach management practices have been updated as a result of the adaptive management process and the availability of new monitoring data on the beach collected by Sonoma Water. These updates are reflected in annual spring updates to the AMP, as well as in ongoing discussion between Sonoma Water and resource agencies. Annual monitoring reports

have documented the change in the beach geometry from year to year and have considered the implications of beach morphology on Estuary water levels across a range of wet and dry years. In response to this, the 2019 update to the *Adaptive Beach Management Plan*, included a revision to the conceptual model of beach morphology and addition of a decision tree for planning beach management.[129] This followed a multi-year review of data in the Estuary, which indicated that outlet channel conditions were unlikely to be maintained for significant periods of time. The decision tree provides more planning flexibility to allow the inlet to remain closed, rather than implementing an outlet channel immediately when water levels were anticipated to reach the lower target water level threshold of 7 feet NGVD29.

Because beach management has evolved over time since the adoption of the *2008 Biological Opinion*, the subsections below describe both the original Proposed Action, the updated understanding of beach morphology and estuarine circulation processes and the revised actions developed through the adaptive management process and documented in the AMP.

Adaptive Management of the Outlet Channel – 2008 Biological Opinion

The *2008 Biological Opinion* tasked Sonoma Water with modifying estuary management during the lagoon management season (May 15 to October 15) by altering artificial breaching practices through creating an outlet channel intended to enhance juvenile steelhead rearing habitat in the Estuary while maintaining the current level of flood protection for properties adjacent to the Estuary. The original AMP was developed by Sonoma Water with assistance from Philip Williams & Associates (now ESA) and the Resource Agency Management Team (Team) in 2009. Because of regulatory permit constraints, Sonoma Water was only able to implement the plan beginning in 2010. The purpose of the AMP is to guide the process of meeting the objective of the *2008 Biological Opinion's* RPA element 2: *Alterations to Estuary Management* to the greatest extent possible while complying with existing permits and minimizing impacts to visual, biological, and recreational resources. The adaptive approach includes tailoring beach management actions to conditions at the time of the action, monitoring to assess beach and Estuary responses, and annual review and revision of the plan.

To meet the criterion for Estuary water level defined in the RPA, the *2008 Biological Opinion* calls for the Estuary to function with "water surface elevation above mean high tide…where freshwater flows out to the ocean over the sandbar at the lagoon's mouth" (p. 92). This implies

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[129] Environmental Science Associates (ESA) & Bodega Marine Laboratory, 2020. Russian River Estuary Adaptive Beach Management Plan. Prepared for Sonoma Water. May 15, 2020.

one-directional flow in the outlet channel, from the Estuary to the ocean, to minimize marine influence and sand transport within the outlet channel to prevent the channel bed from scouring and deepening into a tidal channel. This water level criterion can also be met when the inlet is closed and there is no surface flow across the beach. Artificial breaching may be required when lagoon water levels exceed flood stage of 9 feet NGVD29. With this management plan, the *2008 Biological Opinion* calls for minimization of artificial breaches during the management period while recognizing that such breaches may be needed to minimize flood risk to low-lying properties along the Estuary.

The *2008 Biological Opinion* calls for beach management to form an outlet channel following natural closure events occurring within the management season of May 15 to October 15. From an operational perspective, there were two primary objectives for implementing the outlet channel during the management season: (1) minimize flood risk to low lying properties adjacent to the Estuary, and (2) enhance juvenile salmonid rearing habitat.

To evaluate the goal of improving Estuary rearing for salmonids, beach management had the following performance criteria for the management period:

- **Estuary water levels**. The Estuary water level management target is 7 feet NGVD. Higher Estuary water levels, but not exceeding Sonoma Water’s flood risk minimization target of 9 feet NGVD, would be preferred by NMFS. In addition, water levels greater than 4 feet NGVD are expected to reduce marine conditions and would likely improve juvenile salmonid rearing habitat.
- **Minimize artificial breaching**. Though the *2008 Biological Opinion* calls for avoiding artificial breaching when possible, natural variability of river discharge and nearshore wave conditions limit the degree to which beach management can prevent flooding or water quality issues in the Estuary. As such, NMFS estimates “that [Sonoma Water] will need to artificially breach the lagoon using methods that do not create a perched lagoon twice per year between May 15 and October 15 during the first three years covered by this opinion, and once per year between May 15 and October 15 during years 4-15 covered by this opinion” (p. 302).

Additional criteria for evaluating overall plan success included:

- **Sand channel**. Beach management will be a temporary feature, created only by excavating a sand channel. No new structures or mechanical devices, temporary or permanent, will be a part of beach management.
- **Economic feasibility**. Operations and maintenance requirements will not place undue burden on Sonoma Water in terms of cost, particularly as it relates to frequency or duration of maintenance activities.
- **Public Safety**. The outlet channel management plan will not diminish public safety as it pertains to floodplain property owners, visitors and employees of the State Beach, and Sonoma Water maintenance staff.

Adaptive Management of the Outlet Channel – Revisions

In the initial years following the 2010 implementation of the *2008 Biological Opinion*, management of the beach closely followed guidance of the RPA; focusing on implementation of an outlet channel under appropriate conditions. After two initial attempts to implement an outlet channel in summer 2010, no opportunities to attempt outlet channel implementation occurred until 2016. This lack of attempts stemmed from limitations in naturally-occurring conditions, including: a lack of closure events within the management season, self-breaching of the inlet prior to water levels reaching the threshold of 7 feet NGVD29, an unauthorized public breaching attempt, unfavorable site conditions that did not allow access of equipment, and unsafe wave conditions. These limitations are inherent to the dynamic beach setting and were outside the control of Sonoma Water. Despite these challenges, monitoring continued during these years, along with continued study by Sonoma Water, NMFS, UC Davis, and others regarding salmonid habitat requirements and use of the Estuary as part of the Habitat Blueprint program.

Four unsuccessful attempts at implementing an outlet channel occurred during the 2016 and 2017 management seasons. In response to these continued challenges and continued review of monitoring data, including the recent summary on juvenile steelhead rearing habitat requirements provided by Boughton et al. (2017), NMFS provided feedback that successful management of juvenile salmonid habitat could be better achieved by encouraging longer closure events. This would be accomplished by allowing closures to persist after water levels reached 7 feet NGVD29 (though the upper threshold of 9 feet NGVD29 remained unchanged as a trigger for artificial breaching to minimize flood risk). This change was documented in the 2019 AMP with a new decision tree for beach management during the lagoon management season. This change was ultimately the culmination of several years of review of annual conditions as part of the adaptive management process. During each year, monitoring data from the prior year is reviewed with the resource agency team in the month of March, prior to adopting a plan for the next year. This new process incorporates monitoring data into the decision-making process, so that decisions about outlet channel implementation are based on recent habitat conditions for salmonids in the lagoon. To assist with this, the management season was split into three segments, reflecting different salmonid life stages and tolerance to salinity in the lagoon. Other considerations, such as environmental conditions, beach accessibility to equipment, safety, and harbor seal constraints were also incorporated.

The decision tree was intended to incorporate both seasonal and recent data collected by Sonoma Water and publicly available data collected by other agencies. Some of this data, such as Estuary water levels, are collected continuously and are available in real-time via telemetry. Because these data are readily available, they are often considered real-time throughout the decision-making process. Other data, such as fish monitoring, are only available after post-processing and compilation, so are available less frequently, and used for the adaptive management of the decision-making process (e.g., annual updates to the beach management plan).

Sonoma Water conducts the following monitoring within the Russian River Estuary to inform beach management:

- **Hydrology and geomorphology** (year-round, at sub-hourly intervals)
  - Estuary water surface elevation at Jenner Visitor’s Center and Highway 1 bridge (from USGS)
  - River discharge at Hacienda Bridge (from USGS)

  - Ocean tides and waves (from NOAA)
  - Inlet state, via autonomous camera and event-based staff visits
- **Beach topography** (year-round, at monthly and event-based intervals)
  - Monthly surveys, typically scheduled to coincide with neap tides, when inlet closures are more likely
  - Beach crest elevation surveys, in response to closure events, when feasible
- **Water quality** (May-October, at sub-hourly and variable intervals)
  - Continuous sensors for water depth above sensor, temperature, salinity, specific conductance, dissolved oxygen, and pH, deployed at multiple stations along the Estuary, as well as vertical profiles of these parameters.
  - Weekly and event-based grab samples for nutrient and pathogen testing
- **Fish** (approximately May-October, at varying intervals)
  - Downstream migrant trapping of juvenile salmonids
  - Beach seining and water quality, at multiple shoreline locations to characterize habitat conditions and determine the distribution and abundance fish
- **Pinnipeds** (year-round, at weekly and event-based intervals)[130]
  - Weekly monitoring to establish baseline beach haulout use[131]
  - Event-based when Sonoma Water staff access the beach for surveying or beach management activities

From May 15 through October 15, Sonoma Water monitors and, when indicated, implements beach management actions to minimize flood risk and enhance estuarine salmonid rearing habitat. While maximizing habitat is the priority during this period, minimizing flood risk and preserving water quality remain parallel obligations which can override beach management if warranted.

As described above, the beach is a dynamic setting which is continuously being re-shaped by the combination of ocean waves, ocean tides, and flow between the ocean and the Estuary. For most of the lagoon management period, tidal flows through the inlet scour enough sand to sustain the inlet in an open state. Periodically, ocean waves deposit enough sand to fill in and close the inlet. A closure triggers Sonoma Water's planning and, if necessary, implementation, of beach management.

Once a closure occurs, the decision-making steps for beach management to facilitate lagoon conditions are as follows:

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[130] Pinniped monitoring was not required by the *2008 Biological Opinion*.

[131] Pinniped monitoring frequency was changed under the most recent AMP update and now occurs twice monthly from March 15 to October 15, and weekly during peak pupping in April and May.

1. **Initial Notification** – Sonoma Water notifies the staff from agencies involved with the AMP process (NMFS, CDFW, State Parks, Northern California Regional Water Quality Control Board) by email about the closure and about relevant hydrologic and geomorphic conditions. Sonoma Water also intensifies hydrologic and geomorphic monitoring, by more frequent collection of ocean wave, tide, and riverine discharge data and forecasts, predicting the rate of the Estuary's water level rise, and, to the extent feasible (given staff availability, safe beach access, and marine mammal presence), surveying beach crest elevations.
2. **Gather Information** – Sonoma Water gathers information about current conditions at the Estuary, including both physical and habitat conditions. Using the Estuary water surface elevation, riverine inflow data, and ocean wave forecasts, Sonoma Water performs a forecast of future water surface elevations.
3. **Schedule Next Steps** – Based on the elevation of the beach crest's low point and the water surface elevation forecast, Sonoma Water either decides to continue monitoring or to proceed to preparing a plan for beach management action.
4. **Plan Beach Management Action** – In collaboration with agency staff, Sonoma Water prepares a draft plan for a beach management action. Details regarding the selection of the action's type, timing, location, and dimensions are described in more detail in the AMP. In addition, Sonoma Water strives to include agency staff in iterative plan review and refinement, ideally by hosting a field meeting overlooking the beach about one week before implementation, as schedules, available information, and Estuary conditions allow.

After the plan for beach management activity is finalized, Sonoma Water begins the logistical process for implementation. In the days just before implementation, Sonoma Water confirms beach access plans and conducts marine mammal monitoring, with particular attention to see if recently-born seal pups (neonates) are present and preclude beach access. Safe beach access is also closely monitored up to and during personnel and equipment presence on the beach. Conditions such as wave overwash, de-stabilizing seepage flows, or lack of a sufficiently flat and dry access route can make beach access unsafe. To the extent that other schedule constraints allow, beach management to construct an outlet channel is implemented during a rising tide, to reduce the potential for scour and breaching.

Outlet Channel Performance

Since the implementation of the beach management plan in 2010, persistent outlet channel conditions have not been achieved during the management season. A number of short-lived outlet channel conditions occurred, both managed and natural. These are summarized in **Table 4-6** below, along with all observed inlet closure events lasting more than 20 days.

Natural outlet channel conditions occurred twice, once for eight days in July 2010 and another time for seven days in July 2017. Both conditions ended naturally when wave action fully closed the mouth. An outlet channel was implemented artificially with heavy equipment under five beach management actions, but these generally did not persist more than a week. Four of these events ended with the outlet channel scouring to create a new tidal inlet, while one ended when waves closed the mouth. One of the scouring events was likely related to an artificial breach by beachgoers, based on review of camera data viewing the mouth.

TABLE 4-6
OBSERVED OUTLET CHANNEL AND PROLONGED INLET CLOSURE EVENTS: 2010-2020

Event	Time Period	End Mode	Jenner Gage Water Level (ft)	Limiting Factors
Outlet Channel: Natural	6/27/2010-7/4/2010	Mouth closure	7.2	None
Outlet Channel: Implemented	7/8/2010	Mouth closure	5.6	None
Inlet closure (25 days)	6/8/2013-7/3/2013	Self-breach	7.7	Beach inaccessible – topography
Inlet closure (21 days)	9/24/2013-10/15/2013	Artificial breach	7.4	Water level below 7 ft NGVD29
Inlet closure (35 days)	9/17/2014-10/22/2014	Self-breach	8.7	Beach inaccessible – waves, topography
Inlet closure (24 days)	10/24/2014-11/17/2014	Artificial breach	7.9	After management season
Inlet closure (26 days)	9/8/2015-10/4/2015	Self-breach	6.7	Beach inaccessible - topography
Inlet closure (26 days)	10/10/2015-11/5/2015	Artificial breach	9.3	Beach inaccessible - topography
Outlet channel: Implemented	6/7/2016	Self-breach	7.8	None
Outlet channel: Implemented	6/27/2016	Self-breach	7.8	None
Outlet channel: Natural	6/27/2017-7/3/2017	Mouth closure	7.8	None
Outlet channel: Implemented	7/17/2017	Self-breach	7.8	None
Inlet closure (22 days)	8/5/2017-8/27/2017	Self-breach	8.3	Beach inaccessible - topography
Outlet channel: Implemented	9/28/2017-10/3/2017	Beachgoer breach	8.3	None
Inlet closure (29 days)	10/15/2018-11/13/2018	Self-breach	8.5	After management season
Inlet closure (27 days)	9/28/2020-10/25/2020	Self-breach	7.3	Water level below 7 ft NGVD29
Inlet closure (26 days)	9/28/2021-10/24/2021	Self-breach	11.2	Jenner gage inoperable, estimate from Hwy 1 gage
Inlet closure (25 days)	10/21/2022-11/15/2022	Artificial breach	8.3	None

SOURCE: Sonoma Water, 2023.

Of the nine prolonged closure events that occurred from 2010 to 2020, the majority (6) ended in self-breach. This was most often a result of beach topography impeding safe access of heavy equipment to the preferred outlet channel location at the north end of the beach, due to a sharp drop-off in topography along the northern face of the jetty groin. On two occasions, the inlet breached prior to water levels reaching the management threshold of 7 feet NGVD29. Three inlet closure events ended at or beyond the end of the management season and were ended with an artificial breach.

Estuary Water Surface Elevations

Sonoma Water monitors the Estuary water levels with its tide gage located at the Jenner Visitors Center (about 4,000 feet upstream of the mouth). Since 2019, this gage has been supplemented by a new gage at the Highway 1 bridge, three km upstream of the river mouth. Its installation was initially funded by the NOAA Habitat Blueprint grant, and Sonoma Water currently provides ongoing service of the gage. Data from the gage is hosted online by the USGS.

The *2008 Biological Opinion* Estuary RPA established target water surface elevations, including:

- A daily minimum water surface elevation of 3.2 feet during 70 % of the year.
- An average daily water surface elevation of at least 7 feet from May 15 to October 15.

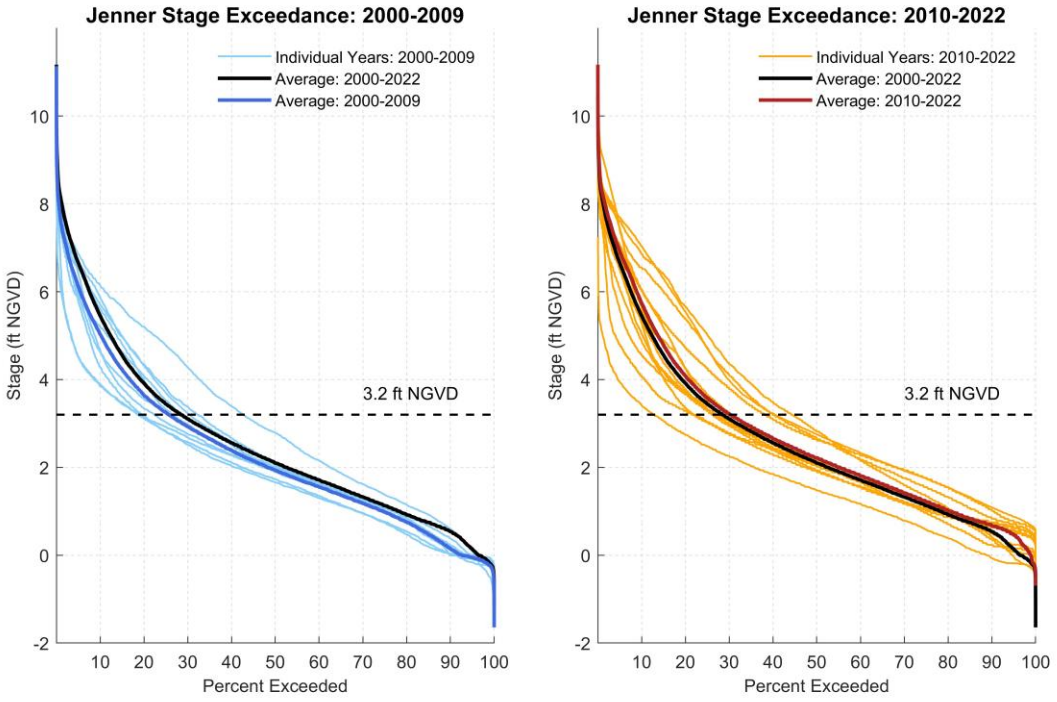
Since 2010, the Estuary water levels have not met the target of remaining above 7 feet NGVD from May 15 to Oct 15. Water levels have also not met the target of remaining above 3.2 feet NGVD for 70% of the year (**Table 4-7**). In both cases, this is largely because the inlet has remained open more often than anticipated by the *2008 Biological Opinion*. In dry years, closure events lasting several weeks in spring and fall months have increased average water levels, but the greatest proportion of the year at or above 3.2 feet NGVD was about 40% in 2014, 2015, and 2017.

TABLE 4-7
YEARLY PERCENT OF ESTUARY WATER LEVELS EXCEEDING RPA TARGET OF 3.2 FEET FROM 2010 TO 2022

Year	Percent of hourly water levels exceeding 3.2 ft NGVD29 at Jenner Gage
2010	30%
2011	13%
2012	21%
2013	28%
2014	44%
2015	40%
2016	38%
2017	41%
2018	20%
2019	28%
2020	28%
2021	28%
2022	25%

SOURCE: ESA (2021b) Attachments E through P. Water levels reported by Sonoma Water Jenner Gage.

Figure 4-9 summarizes annual water level exceedance observations from 2000 to 2022. The left and right panels separate the data into periods before and after implementation of the Estuary Management Project began in 2010. These data indicate that management beginning in 2010 had little effect on water level exceedance. The largest change among years appears to have resulted from changes in river discharge, with the driest years having the longest closure events. Closure behavior is not exclusively tied to riverine discharge, because the initiation of closure events is caused by waves. Even if river discharge were to remain constant between years, differences in wave action throughout the year would lead to changes in the timing of closure events. However, in most years there is sufficient wave energy to cause closure in many months of the year. During dry years, riverine discharge is often reduced, which raises estuarine water surface elevation more slowly, thereby allowing closures to last longer and water surface elevations above the oceanic tide range to persist for longer. Another notable change has been a slight shift toward higher breach elevations in recent years in response to adaptive changes in management of the beach and Estuary. The increase is on the order of several tenths of a foot, but is not statistically significant (meaning there is high variation in the overall trend). This change has not significantly raised average water levels in the Estuary.



SOURCE: Sonoma Water Jenner Visitors Center gage

Figure 4-9
Annual water level exceedance curves in the Russian River Estuary relative to the RPA target of 3.2 feet NGVD29

4.3.7.7 Jetty Study

Under *Section X.A.2.1.2.* of the RPA*: Investigation of Jetty Impacts on Permeability and Lagoon Formation and Evaluation of Jetty Removal*, NMFS states:

> *"If adaptive management of the outlet channel... is not able to reliably achieve the targeted annual and seasonal estuary management water surface elevations by the end of 2010, SCWA* [Sonoma Water] *will draft a study plan for analyzing the effects and role of*

> *the Russian River jetty at Jenner on beach permeability, seasonal sand storage and transport, seasonal flood risk, and seasonal water surface elevations in the Russian River estuary. That study will also evaluate alternatives for achieving targeted estuarine management water surface elevations via jetty removal, partial removal of the jetty, jetty notching, and potential use of the jetty as a tool in maintaining the estuary water surface elevations described above."* (p. 250)

The Feasibility Study of Alternatives to Goat Rock State Beach Jetty for Managing Lagoon Water Surface Elevations ('Jetty Study') was initiated in 2011 and completed in 2017.[132] In accordance with the RPA, the study examined the condition and characteristics of the existing jetty structure, assessed groundwater permeability, and investigated wave-driven sand transport and inlet and beach morphology. Based on this understanding of the physical setting, the study also compared four alternatives for modifying the jetty and compared these to the no-action alternative. The purpose of this evaluation was to determine whether the jetty could be modified to help achieve the water surface elevation objectives of the RPA.

Jetty Components and Effects on Beach Morphology

Investigation of the components of the jetty structure was a key part of the study. Because much of the jetty is buried in the beach sands and its documentation was minimal, the extent and composition of much of the jetty was uncertain at the time the *2008 Biological Opinion* was issued. The Jetty Study incorporated review of as-built drawings, review of historical references, and a field survey of the jetty. The jetty (referred to alternately in the study as the 'jetty complex') comprises several components, constructed between 1924 and 1948, not all of which are visible at the surface. This includes railway and rock fence built by 1930, an additional rock groin completed in 1930, a seawall and roadway for transporting materials completed by 1939, and the final rock and cement groin completed by 1941 (**Figure 4-10**). Construction was completed by the Russian River Improvement Company (RRIC) with funds from the RRIC, private sources, the Fish and Game Preservation Fund, the State of California, and later by the California Division of Water Resources with funding from the Fish and Game Commission and Sonoma and Mendocino counties. The jetty's original purpose was to maintain permanent boat navigation through the inlet, primarily to facilitate transport of mined gravel from the river. Maintaining an open river inlet for fish passage became an additional objective after the initial phase of construction. Currently, the jetty is owned by California State Parks and Recreation Department as part of the Goat Rock State Beach (GRSB).

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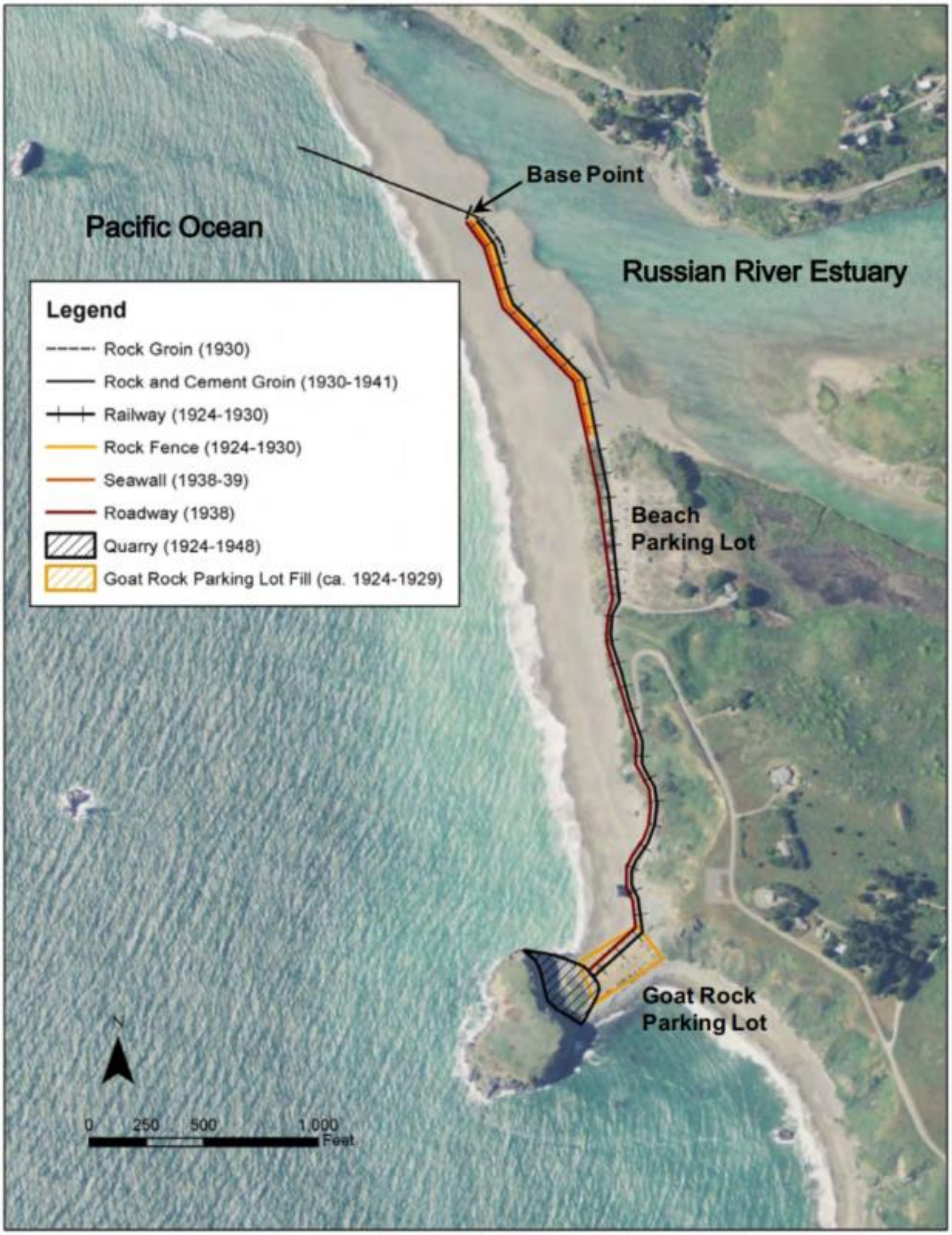
[132] Environmental Science Associates (ESA), 2017. *Op. cit.*



SOURCE: ESA (2017)

Figure 4-10
Plan view of Goat Rock State Beach jetty complex elements and timing of their construction between 1930 and 1941

In total, over 100,000 tons of rock were quarried from Goat Rock and the adjacent bluff over several construction phases and placed in excavated pits to build the groin and a protective rock fence for a steel railway. An extensive amount of redwood lumber was also used in the construction of the groin, seawall, and railway. In addition, the sandbar or tombolo between Goat Rock and the mainland was filled and is now a parking lot. Construction of the jetty complex is summarized in detail in Chapter 2 of the Jetty Study and briefly here. Currently, several original components of the jetty remain embedded in GRSB:

- A railway (c.1930) from the base of Goat Rock to the existing location of the jetty groin.
- A rock fence (c.1930) designed to protect the railway from wave action.
- A timber seawall (c.1939) built to stabilize the beach and limit erosion in the vicinity of the rock fence and railroad.
- A compacted fill roadway (c.1940) located landward of the railway.
- A rock and concrete jetty groin (constructed in phases in 1934, 1941, 1948).

Presently, remnants of all these components are visible in the beach (**Figure 4-11**), but the jetty groin remains the most prominent feature, as it protrudes into the surf zone and limits southward migration of the inlet.

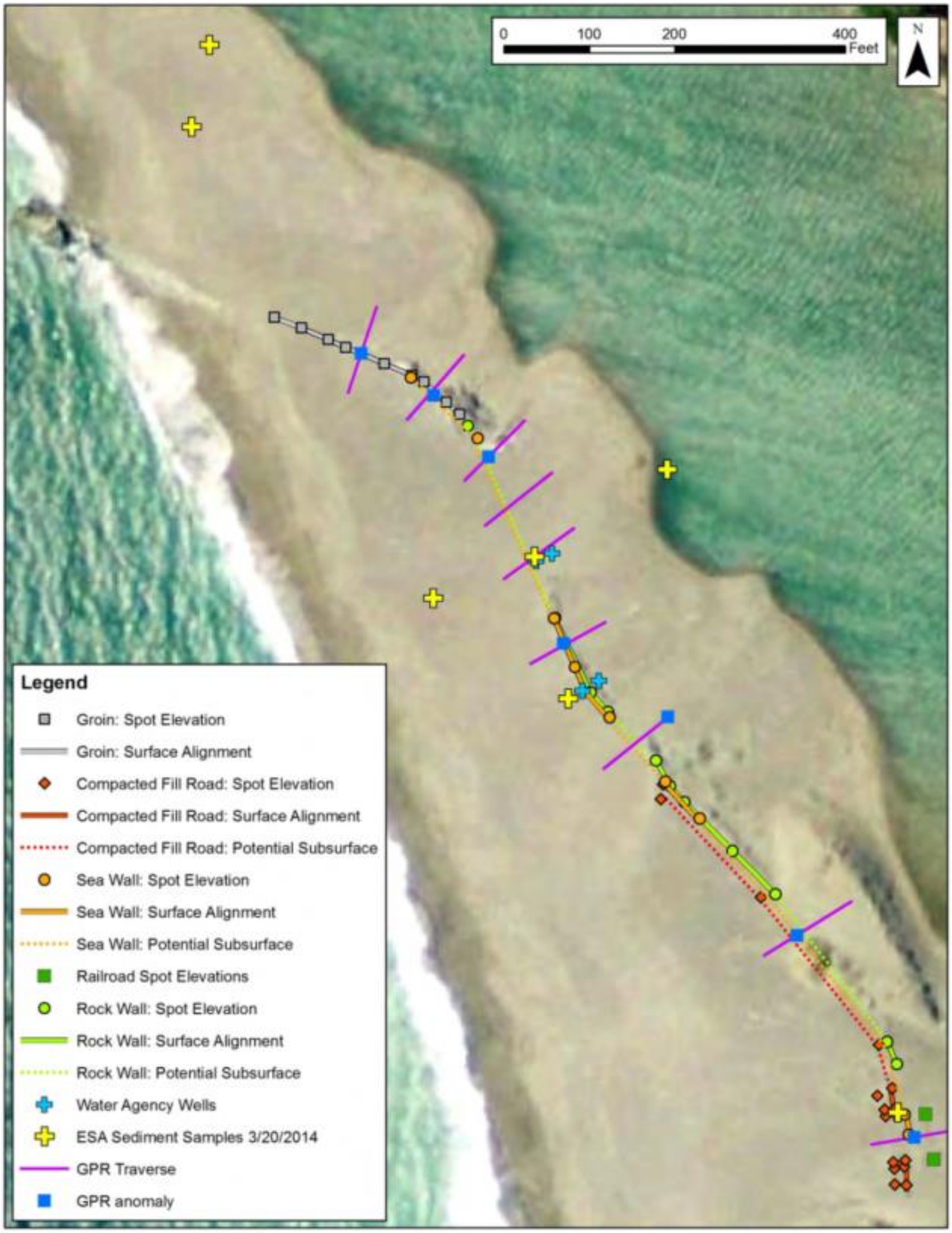
The Jetty Study found that, in addition to blocking inlet migration south of the groin location, the jetty components likely affect beach morphology in other ways. Construction of the state beach parking lot between Goat Rock and the mainland has contributed to the long-term growth of the beach between the groin and Goat Rock. By replacing a sandbar (tombolo) with an elevated parking lot, the natural southward movement of sand along the shore is blocked, leading to sand accumulation north of the parking lot. This was evident from comparison of shoreline positions obtained from historical aerial images, which showed roughly 1 foot of growth per year to the north of the parking lot, and 1 foot per year of erosion immediately to the south (Blind Beach). The buried components in the remainder of the beach also appear to have limited wave overwash and associated erosion in the portion of GRSB between the groin and the beach parking lot (Figure 4-10), making the beach in this region larger than similar bar-built estuaries in northern California. Wave overwash is a natural process in which ocean waves run up the beach face and reach an elevation that exceeds the beach crest. When this occurs, water and eroded beach sand wash into the Estuary. The fortification of the beach with jetty components appears to have allowed the beach to accumulate sand without experiencing significant coastal erosion. This also affects Estuary water surface elevations, since wave overwash can be a component, as described below.

Jetty Influence on Seepage through the Beach

The study also included a groundwater permeability assessment, which relied on field measurements conducted in Goat Rock State Beach by the Lawrence Berkeley National Laboratory (LBNL), NORCAL Geophysical Consultants, and Sonoma Water staff. The study included installation of groundwater wells in the beach, seismic refraction (SR), ground penetrating radar (GPR), and electrical resistivity tomography (ERT). This effort is described in Chapter 3 of the Jetty Study, and a study map shown in **Figure 4-12** illustrates the location where

SOURCE: ESA (2017)

Figure 4-11
2014 site photos of Goat Rock State Beach jetty access elements



SOURCE: ESA (2017)

Figure 4-12
Plan view of Goat Rock State Beach jetty elements mapped in the field, and groundwater study locations

different field measurements were employed in the beach. These measurements identified the subsurface location and extent of the jetty components.

Though no single method creates an entire picture of groundwater flows, together, each of these field measurements was useful in identifying several important findings:

- GPR surveys found varying depths of bedrock underlying the beach, suggesting that historically the bedrock would not have prevented the inlet from migrating south of the jetty groin before the jetty was constructed.
- The rock seawall may have deteriorated and is absent within the beach in areas where it is not visible at the surface.
- Subsurface flows between the ocean and the Estuary are present in locations where the jetty components (rock fence, seawall, and roadway) are absent in the beach. Seepage velocities were estimated to be 3.7 times faster (36-50 ft/hr) in sections where the jetty is absent as compared to sections where it is present (10-14 ft/hr).
- Freshwater flow (seepage) through the beach from the Estuary to the ocean intensifies during low tides.
- Groundwater flows through the beach are layered, with a wedge of saltwater underneath a freshwater lens closer to the surface. The elevation of this salinity transition varies over time, but generally the lower saltwater wedge moves toward the Estuary while the freshwater lens at the surface moves toward the ocean through the porous beach.
- During inlet closure, water levels in the Estuary are persistently higher than ocean levels, indicating there is a hydraulic gradient that encourages more groundwater flow from the Estuary to the ocean through the beach. Observations of the subsurface layers found that during closure the groundwater within the beach gradually converts to almost completely freshwater, meaning that groundwater flow through the beach is dominated by flow toward the ocean (i.e., seepage losses from the Estuary to the ocean increase during closure).

Jetty Influence on Lagoon Water Surface Elevations

Based on the above findings, a Quantified Conceptual Model (QCM) model was developed from Estuary water levels and predicted the potential effects of removing all or parts of the jetty.[133] The QCM is a hydrologic model of the Estuary that incorporates a time-varying inlet in the beach. By accounting for river inflow, inlet size and closure, tides, and wave action, the model predicts Estuary water levels.

To predict potential changes in Estuary water levels resulting from the jetty modification alternatives, the study incorporated findings from the groundwater investigation. It also considered other effects of the alternatives, such as their capacity to allow increased migration of the inlet and greater wave overwash to the Estuary. The modeling approach relied on the assumption that removal of the jetty groin would allow unconstrained migration of the inlet to the south, which can increase seepage losses and likelihood of inlet closure (due to increased friction of an elongated channel). It also relied on the assumption that removing components of the jetty

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[133] Behrens, D., Brennan, M. & Battalio, B. 2015. A quantified conceptual model of inlet morphology and associated lagoon hydrology. Shore and Beach. 83. 33-42.

in the beach would both (1) increase wave overwash into the Estuary, and (2) increase seepage due to increased permeability of the beach profile.

The results of this modeling found that the three alternatives that include removing some or all of the jetty would not substantially contribute to the objective of more frequent or sustained lagoon conditions and the corresponding increase in Estuary water levels. While the fourth alternative of notching the jetty to act as a weir might facilitate longer lagoon conditions in some years, this alternative has other feasibility constraints on managing channel erosion, as well as potential impacts to public safety and the environment (from deconstruction of jetty elements).

Flood Risk Reduction

Under *Section X.A.2.1.3.* of the RPA*: Flood Risk Reduction*, NMFS included a series of flood risk reduction actions to be implemented if it proved difficult to reliably achieve raised water surface elevation targets based on implementation of a lagoon outlet channel or modification of the existing jetty. Should those other actions be unsuccessful in meeting estuarine water surface elevation goals, RPA 2 states that the Sonoma Water:

> *"will evaluate, in coordination with NMFS and other appropriate public agencies, the feasibility of actions to avoid or mitigate damages to structures in the town of Jenner and low-lying properties along the Estuary that are currently threatened with flooding and prolonged inundation when the barrier beach closes and the Estuary's water surface elevation rises above 9 feet. Such actions may include, but are not limited to, elevating structures to avoid flooding or inundation."* (p. 251)

The *2008 Biological Opinion* called for a series of flood risk reduction actions, culminating in a *Flood Risk Study*, if creating an outlet channel is unsuccessful at managing Estuary water surface elevations. The first action the *2008 Biological Opinion* calls for compilation of a preliminary list of structures, properties, and infrastructure that would be subject to flooding/inundation as the result of sandbar formation and if the Estuary were allowed to naturally breach. Sonoma Water complied with this action by submitting a preliminary list of properties, structures, and infrastructure that may be subject to inundation. This preliminary list was updated for the California Coastal Commission Coastal Development Permit application process. Allowing Estuary water surface elevations to rise to between 10 and 12 feet NGVD (the estimated water surface elevation if the barrier beach was allowed to naturally breach per consultation with NMFS) may potentially inundate portions of properties.

The second effort involved identifying funding mechanisms to provide grants or loans to property owners to avoid or mitigate damage to structures from flooding during prolonged Estuary closures. Sonoma Water was awarded federal funding from the National Oceanic and Atmospheric Administration (NOAA) Habitat Blueprint framework to provide funds to USGS for expansion of its sea level rise model (the Coast Storm Modeling System or CoSMoS). This model included the Estuary up to Duncans Mills and was intended to inform flood risk assessments in Estuary management efforts for both open and closed river mouth conditions.[134] The model was

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[134] Available at https://www.usgs.gov/centers/pcmsc/science/coastal-storm-modeling-system-cosmos#overview.

also intended to provide an estimate of potential for future flooding with sea-level rise, which is not included in Flood Insurance Studies from the Federal Emergency Management Agency. The results from these model scenarios were incorporated into flood risk mapping on the Our Coast, Our Future (OCOF) web platform by Point Blue Conservation Science (https://ourcoastourfuture.org/case-studies/).

As part of the Goat Rock State Beach Jetty Feasibility Study, ESA also worked with Sonoma Water to assess flood hazards in the Estuary. This included evaluation of potential flood levels from high river discharge, from estuarine flooding (flooding due to water ponding behind the beach during periods of inlet closure), and from wave transmission through the mouth and run-up onto the interior shoreline of the Estuary. Several key findings from the assessment include the following:

- Estuarine flood levels may be higher than levels from fluvial flooding alone. The 10-year recurrence fluvial flood event was estimated to be 9.25 +/- 0.25 feet NGVD29, versus 11.2 feet NGVD29 for an estuarine flooding event. The two sources are similar for the 100-year recurrence flood, at 13.4 and 13.9 feet NGVD29, respectively. Observations from 1999 to 2015 also showed a disparity, with maximum fluvial flood levels in Jenner of 9.8 feet NGVD29 (January 1, 2006) versus 12.2 feet NGVD29 (December 12, 2015) for estuarine flooding.
- Flood risk from wave run-up is less likely to occur and is dependent on the local shoreline slope. The study found that the largest non-breaking waves that could enter the mouth of the Estuary would be approximately 6 feet high and would need to pass through the inlet during high tide during a period when the mouth is very wide (e.g., after a major flood event), but with river discharge having declined to a level where ocean tides can reverse the flow through the inlet. Under this scenario waves entering the Estuary were estimated to reach a run-up height of 11.0 feet NGVD29 for portions of the shoreline with a slope of 10H:1V, and possibly as high as 25.1 feet NGVD29 where slopes are as high as 2H:1V.

4.3.7.8 Water Quality Monitoring

In bar-built estuaries such as the Russian River Estuary, water levels and water quality conditions are substantially influenced by the state of the barrier beach. Estuaries with relatively large watersheds and corresponding high annual river discharge tend to have a more eroded beach, tend to be deeper, have higher frequency of open connections to the ocean, and generally have more marine (saltier and colder) water quality conditions. This includes systems such as the Smith, Eel, and Klamath River estuaries along the northern California coast. Conversely, smaller estuaries, or estuaries with lower river discharge, tend to have a more stable beach, and tend to remain closed for large portions of the year, leading to conditions with relatively more freshwater volume, as discussed for the Carmel River and Scott Creek estuaries in Section 4.3.7.5, *Comparison with Other Estuaries*.

The distribution and abundance of fish species, including salmonids, within the Russian River Estuary is dependent, in part, on water quality conditions, which in turn are dependent on a wide variety of physical conditions such as open or closed inlet condition (presence of a barrier beach), fresh riverine discharge, ambient air temperature, wind action, and tidal circulation. These water quality characteristics create a range of habitat conditions that favor different species of fish. Water quality characteristics which determine fish habitat within the Estuary include temperature, DO, and salinity. Depending on the state of the barrier beach (open to tidal influence or closed), these water quality characteristics can vary across a wide range and can change rapidly within the Estuary.

Sources of Water Quality Data

This section summarizes information on water quality conditions in the Estuary from several previous reports and from monitoring data provided by Sonoma Water and UC Davis Bodega Marine Laboratory (BML):

- **The Estuary Project Environmental Impact Report:**[135] This report describes the environmental setting that reflects the baseline condition based on information collected by Sonoma Water and other groups prior to the adoption of the *2008 Biological Opinion*.
- **Stationary sonde data collected in the Estuary:** The *2008 Biological Opinion* called for Sonoma Water to continue monitoring salinity, specific conductance, water temperature, dissolved oxygen (DO), and pH during spring, summer, and fall months in the Russian River Estuary, and to evaluate changes in these parameters resulting from adaptive sandbar management. Sonoma Water has conducted this monitoring since 2009, summarizing their results in annual monitoring reports that are available online.[136] Estuary water quality is monitored using multi-parameter, continuously-recording YSI 6600 water quality meters (sondes). Sondes have been deployed at several stations throughout the lower, middle, and upper reaches of the Estuary, as well in locations near Patterson Point and Monte Rio that are within the lagoon that forms upon river mouth closure. Their original locations were based on Martini-Lamb et al. (2005) and additional stations have been added since 2009.[137]
- **Boat-based water quality profiles:** Sonoma Water sondes have also been supplemented since 2009 by boat-based water quality profiling, as summarized by Largier (2021).[138] This boat-based data collection by BML is not required by the *2008 Biological Opinion*, but Sonoma Water funds this effort to describe physical processes and circulation within the Estuary. This monitoring typically occurs several times during inlet closure events within the management season.[139] **Figure 4-13** illustrates the locations where data are currently collected within the Estuary. A number of temporary locations were also formerly included in the sampling effort, including near the mouth and near the Highway 1 crossing at Bridgehaven (not shown).
- **Review of sonde data:** ESA (2021c) analyzed the observed variability in Sonoma Water's stationary sondes after 2009. This analysis shows how salinity, DO, and temperature vary along the length of the Estuary, by season, and by inlet closure duration.[140]
- **Grab sampling:** Since 2010 the NCRWQCB, Sonoma Water, and Sonoma County DHS have collected grab samples[141] to be analyzed for indicator bacteria as part of the annual freshwater beach monitoring program at several sites on the Russian River.

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[135] Environmental Science Associates, 2010. *Op. cit.*

[136] https://www.sonomawater.org/fisheries-monitoring

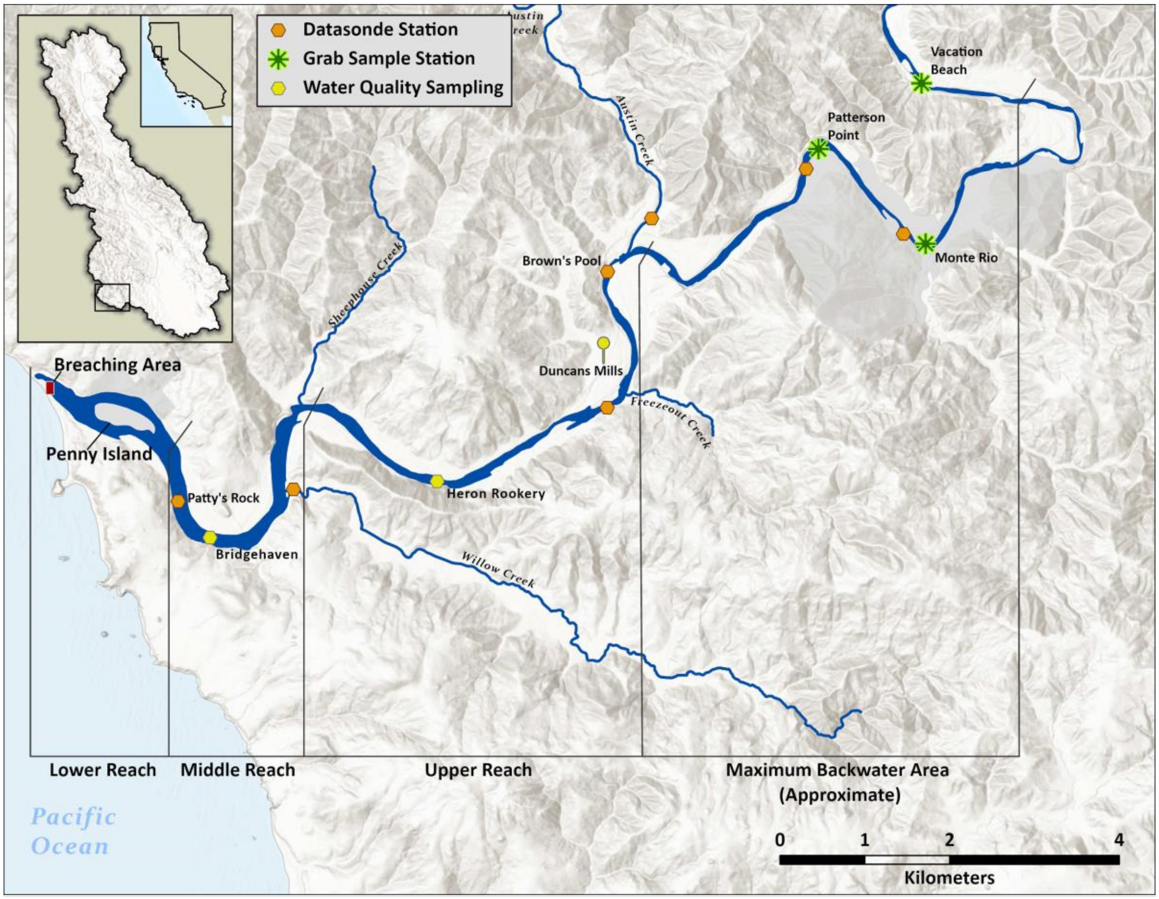
[137] SCWA, Russian River Estuary Sandbar Breaching Monitoring Plan, 2005, prepared by Jessica Martini-Lamb, Jeff Church, David Cook, Josh Fuller, and David Manning, September 2005.

[138] Largier, J. 2021. Description of Juvenile Steelhead Habitat Scenarios in the Russian River Estuary. Prepared for Sonoma County Water Agency, 42 pg.

[139] Largier, J. 2021. *Op. cit.*

[140] ESA. 2021b. *Op. cit.*

[141] Grab samples are samples of water collected from the water column in sample jars and bottles for lab analysis.



SOURCE: Martini-Lamb et al. (2017)

Figure 4-13
Current Estuary water quality monitoring locations

Additional data on water quality are also collected by Sonoma Water staff at fish seining locations. More information, including relationships between water quality and features such as prey availability for juvenile salmonids and water column depth, are provided in studies by Matsubu et al. (2017), and in Boughton et al. (2017).

Spatial Patterns During Open Conditions

Salinity

The Estuary exhibits conditions typical of estuarine environments with varying salinity levels. Salinity steadily increases from low levels (0-5 parts per thousand [ppt]) at the river/Estuary interface in the upper reach, to moderate or brackish levels in the middle reach (approximately 10-20 ppt), to near seawater from the ocean in the lower reach (30-35 ppt).

Saline water is denser than freshwater and a salinity “wedge” forms below freshwater outflow that passes over the denser tidal inflow. The lower and middle reaches of the Estuary up to Sheephouse Creek are predominantly saline environments with a surface freshwater layer that flows over the denser saltwater. The upper reach of the Estuary transitions to a predominantly freshwater environment, which is sometimes underlain by a denser, brackish layer that migrates upstream as far as Brown's Pool upstream of Duncans Mills during summer low flow conditions. River flows, tides, and wind affect the amount of mixing at various longitudinal and vertical positions within the Estuary. However, as in most estuaries, water stratification is more common in deeper sections of the Estuary or when vertical mixing is limited.

When the Estuary is open during the late spring and early summer, and fall, salinities in much of the Estuary are greater than the tolerable range for younger ages of juvenile of the year (YOY, age 0+) steelhead that have not yet acclimatized. By late summer and fall, however, at least some steelhead YOY can tolerate high salinity as demonstrated by individuals previously PIT-tagged as YOY in freshwater that are later recaptured in near full-strength seawater in the lower reach of the Estuary.[142,143] Water quality data indicates that when the Estuary is open to tidal mixing, the most upstream portion of the Estuary from Freezeout Creek to Austin Creek (upper 1.6 km of the Estuary) is the only portion where predominantly freshwater habitat is maintained throughout the summer. The lower and middle Estuary are predominantly saline environments with only a thin freshwater surface layer. The middle Estuary (1 to 8 km from the mouth) is most subject to fluctuation in salinities throughout the water column due to ocean tides. In the middle Estuary, salinities can range as high as 30 ppt in a saltwater layer at the bottom, with brackish conditions prevailing at the upper end of the salt wedge, to less than 1 ppt in the freshwater layer on the surface. Salinities near the mouth are similar to ocean salinities.[144]

Dissolved Oxygen

DO levels in the Estuary fluctuate significantly during the monitoring season, and fluctuations are not necessarily associated with tidal cycles or a diurnal cycle.[145] DO levels in the Estuary depend upon factors such as the extent of diffusion from surrounding air and water movement including freshwater inflow. DO levels are also a function of nutrients, which can accumulate in standing water during an extended period and thus promote high plant and algal growth. Estuaries tend to be naturally eutrophic because land-derived nutrients drain from the entire watershed to an estuary before entering the marine environment. During their growth stages, plants and algae emit DO. However, as these species die off and decay, this decomposition consumes DO, resulting in low DO conditions.

DO concentrations also affect habitat quality and use, physiological stress, and mortality of fish and other aquatic organisms. In general, DO concentrations less than 5 to 6 milligrams per liter (mg/l) are unsuitable for most cool-water fish species, including steelhead.[146,147] Salmonids generally require a DO level of at least 8 mg/l for optimal growth and survival, and depending on temperature, the lower lethal limit for salmonids is a DO level of around 3 mg/l. When the Estuary is open, DO typically ranges from approximately 7 to10 mg/l in the surface layers, and varies, on average, from 4 to 9 mg/l in bottom areas of Estuary pools. However, deeper pools

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[142] Martini-Lamb, J. and Manning, D.J. editors. 2022. Russian River Biological Opinion Status and Data Report Year 2021. Sonoma County Water Agency, Santa Rosa, CA.

[143] SCWA, 2006. Russian River Estuary fish and macro-invertebrate studies, 2005. SCWA, Santa Rosa, CA. 35 pages.

[144] SCWA, 2006. Op. cit.

[145] SCWA, 2006. Op. cit.

[146] Barnhart, R.A. 1986. Species Profiles: Life histories and environmental requirements of coastal fishes and invertebrates – steelhead. U.S. Fish and Wildlife Service, Biological Report 82 (11.60). USACE, TR EL-82-4.

[147] Bell, M.C. 1991. Fisheries handbook of engineering requirements and biological criteria. USACE, Portland, OR.

(where tidal flushing is difficult due to the topography of the bed, and residence times are longer), experience hypoxic or anoxic conditions even during open Estuary conditions.

Temperature

Water temperature has direct and indirect effects on aquatic ecology. For example, oxygen is more soluble in cold water than warmer water (i.e., solubility is a function of water temperature). Therefore, DO levels may be higher in lower temperature waters. Water bodies such as the Russian River Estuary have naturally fluctuating temperatures due to the dynamic conditions associated with a coastal climate, localized weather patterns, and tidal mixing.

Temperatures recorded during open Estuary conditions during summer typically range from 10°C to 18°C at mid- and bottom-depths in saline and brackish water. Temperatures are generally warmer in the freshwater layer, which can reach as high as 25°C for short periods, especially in the upper reach of the Estuary, furthest from the natural cooling effects of a marine environment. Temperatures less than 18°C are associated with positive growth rates in juvenile steelhead. In general, salmonids in warmer waters require more food and oxygen because their metabolism increases with temperature.[148] The high productivity associated with healthy estuaries provides an abundant food source for many fish species and can allow temperature-sensitive fish, such as juvenile salmonids, to withstand greater water temperatures than the typical optimal range and can result in increased growth rates.[149]

Seasonal Patterns

ESA (2020) and Largier (2021) summarized seasonal changes in the Estuary from May to October, and changes during inlet closure conditions and other inlet states (outlet channel, muted tidal, wide open tidal).[150] Seasonal changes in salinity, temperature, and DO were found to differ by Estuary location and depth in the water column:

- Salinity in the lower and middle reaches of the Estuary (from the mouth to Sheephouse Creek) tends to be highest in the months of July, August, and September, coinciding with low river flows and a relatively low chance of inlet closure (i.e., when open inlet conditions introduce saltwater daily).
- Salinity in the upper Estuary tends to be highest in summer and fall which coincides with low inflow and a high chance of closure. It is common for saltwater to reach the upper Estuary during closure events, especially events lasting longer than several weeks. This occurs as trapped saline water has enough time to settle and spread upstream. However, inlet-closure is not the only control, and low river discharge paired with high tides can result in salinity movement into the upper Estuary during open Estuary conditions as well.
- Seasonal temperatures at the surface in the lower and middle Estuary are mostly controlled by weather conditions on the coast and show a large amount of variability for all months where data are available. In the upper Estuary, water temperatures are more dependent on the temperature of freshwater inflow. As a result, surface temperatures in the upper Estuary are higher, but less variable and tend to peak in July and August.

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[148] Moyle, P.B. 2002. Inland Fishes of California. University of California Press.

[149] Bond et al., 2008. *Op. cit.*

[150] Environmental Science Associates (ESA) & Bodega Marine Laboratory, 2020. *Op. cit.*

- Bottom temperatures appear to be heavily influenced by the presence of saltwater. When saltwater moves upstream during low river discharge conditions or during periods of inlet-closure, it often coincides with warmer temperatures at mid-depths (within the halocline), while overlying colder saltwater at the bottom.
- As with temperature, DO appears to be more closely tied to the presence of saltwater than season. DO in the surface layer tends to be high for all sites, but in the bottom layer, there is a higher amount of variability. Since inlet closures that trap saltwater have occurred most months of the historical record the observed variability in DO in the bottom layer does not follow a seasonal pattern.

Patterns During Inlet Closure

When the inlet closes, tidal circulation is cut off in the Estuary, and water quality conditions are largely controlled by the layering of freshwater at the surface over saltwater below. Salinity, DO, and temperature changes can begin within 24 hours of inlet closure. As upstream inflow begins to fill the now closed Estuary, the freshwater layer begins to thicken at the surface, starting at the mouth and extending upstream. Concurrently, salt water may migrate upstream underneath the thickening freshwater layer, thereby increasing salinity upstream. When muted tidal conditions occur for the days leading up to closure, some of the common shifts (saline water settling to the bottom, decreasing DO, warming conditions) begin more rapidly. The available sonde and boat-based data show a consistent pattern over the length of closure events:

- Trapped saltwater spreads upstream along the bottom, leading to low to anoxic DO at depth and warmer water at the fresh/saline interface. Typically, salinity steadily increases from the freshwater/Estuary interface in the upper reach with low salinity (0-5 ppt), to a predominantly saline environment with a thin freshwater layer that flows over the denser saltwater in the lower and middle reaches of the Estuary. Highly saline conditions are present in the mid and bottom depths of the lower and middle reaches of the Estuary within a few days of inlet closure. While surface water becomes fresh, deeper saline water at the bottom may persist in the lower Estuary, and saline water may migrate upstream to the middle Estuary due to reduced velocities of river inflows and redistribution of the saltwater wedge. Trapped saltwater sometimes reaches as far upstream as Brown’s Pool (Figure 4-13) during periods of inlet closure.
- When the inlet closes, salinity stratification results in pronounced DO stratification in the closed lagoon. DO fluctuations increase in the mid and upper depths and the bottom depths experience sharp drops in DO concentrations. Data from 1996 to 2000 monitoring indicates stratification, with hypoxic to anoxic conditions in the near-bottom layers of the Estuary within a few days of closure. Supersaturation, hypoxic, and anoxic events were observed, with prolonged hypoxic and anoxic events occurring at the bottom through the duration of Estuary closure. Decreasing DO concentrations were also observed in the middle layers of the water column during barrier beach closures. In deeper pools, DO typically drops to less than 5 mg/l.[151]
- During open Estuary conditions, mainstem water temperatures are reflective of the halocline, with lower mean and maximum temperatures typically being observed in the saline layer at the bottom and mid-depth sondes compared to temperatures recorded in the freshwater layer at the mid-depth and surface sondes. The differences in temperatures between the underlying

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[151] SCWA, 2006. *Op. cit.*

saline layer and the overlying freshwater layer can be attributed in part to the source of saline and freshwater. During open Estuary conditions, the Pacific Ocean, where temperatures are typically around 10°C, is the source of saltwater in the Estuary. Whereas the mainstem Russian River, with water temperatures reaching as high as 27°C in the interior valleys, is the primary source of freshwater in the Estuary.

- During closed Estuary conditions, increasing temperatures associated with fresh/saltwater stratification are observed to occur in the middle reach. Density and temperature gradients between freshwater and saltwater play a role in stratification and serve to prevent/minimize mixing of the freshwater and saline layers. During the warmer dry months of summer and fall, when the Estuary is closed or the river mouth is perched and the supply of cool tidal inflow is reduced, solar radiation heats the overlying freshwater surface layer and underlying saline layer. The overlying freshwater surface layer restricts the release of this heat from the underlying saline layer, which can result in higher water temperatures in the underlying saline layer than in the overlying freshwater layer. Stratification-based heating has also been observed to result in higher temperatures in the mid-depth saline layer compared to the bottom layer in deep pools, forming a three-layered water column. This stratification-based heating can also contribute to higher seasonal mean temperatures in the saline layer than would be expected to occur under open conditions.
- The longest closure events from 2009-2020 lasted 4-5 weeks and showed signs of decreasing salinity in the lower reach's mid-depths, possibly due to seepage of saline water from the Estuary through the barrier beach to the ocean.
- Observations are not available for longer closure events that may have occurred historically, but modeling from UC Davis suggests that over several months, salinity would continue to decrease near the mouth, but not enough to allow freshwater to occupy the entire water column within the timeframe of the management season.[152]

Table 4-8 provides a broader summary of observed changes in estuarine water column conditions during various conditions in the Estuary. The table was developed by ESA (2021b) based on review of Sonoma Water data from continuous sondes and boat-based vertical profile data collected by UC Davis. The table summarizes the observed changes in salinity, temperature, and DO for open-inlet conditions, muted conditions in the week prior to closure, the date of closure, and conditions at 1, 2, and 4 weeks from the beginning of closure.

4.3.7.9 Habitat Focus Area

The Russian River is designated as a Habitat Focus Area (HFA) under NOAA's Habitat Blueprint program.[153] HFA sites are targeted places where NOAA focuses its programs and investments to address a high priority habitat issue by working with partners and communities. As a partner in the Russian River HFA, Sonoma Water has worked with NOAA, ESA, and the BML to model salmonid rearing habitat in the Estuary. This is complementary to the studies conducted for the *2008 Biological Opinion* but has been a key component of the adaptive management process.

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[152] Largier, J. 2021. *Op. cit.*

[153] NOAA grant award #NA14NMF4630214

TABLE 4-8
TYPICAL OBSERVED SHIFTS IN WATER QUALITY CONDITIONS DURING CLOSURE

Inlet State and Time Period	**Lower Estuary** **Mouth**	**Middle Estuary** **Patty’s Rock, Bridgehaven, Willow Cr (at confluence) Sheephouse Creek**	**Upper Estuary** **Heron Rookery, Freezeout Cr, Browns Pool, Austin Cr**	**Notes**
Wide open: >1 week before closure	S: Mixed, oceanic	S: Mixed, brackish	S: Mixed, fresh	Strong tidal influence in the Lower and Middle Reaches, fresher conditions upstream. Well mixed. Low water levels.
	T: Cold	T: Cold	T: Warm	
	DO: High (well mixed)	DO: High (well mixed)	DO: High (well mixed)	
Muted: <1 week before closure	S: Stratified, oceanic at depth	S: Stratified, brackish at depth	S: Stratified, brackish at depth	Reduced tidal exchange allows freshwater upper layer to form/thicken. Stratification and initial settling of saltwater. Low water levels.
	T: Cold	T: Cold	T: Warm	
	DO: Declining at depth	DO: Declining at depth	DO: High; if brackish declining at depth.	
Day of Closure	S: Mixed (wave overwash), oceanic	S: Stratified, increasingly oceanic at depth	S: Stratified, brackish at depth	Oceanic influence at mouth from significant wave overwash during closure. Additional saltwater trapped.
	T: Cold	T: Cold	T: Warm	
	DO: Low at depth	DO: Low at depth	DO: High; if brackish declining at depth.	
1 Week after closure	S: Stratified, oceanic at depth	S: Stratified, oceanic at depth	S: stratified, brackish at depth	Trapped saltwater at mouth settles into Middle Reach at depth. Loss of tidal exchange allows temperature to increase. Declining DO at depth where saltwater is trapped.
	T: Warm, increasing	T: Warm, increasing	T: Warming during peak summer air temperatures	
	DO: Declining at depth	DO: Declining at depth	DO: Declining at depth	
2 Weeks after closure	S: Stratified, oceanic at depth	S: Stratified, oceanic at depth	S: Stratified, increasingly brackish at depth	Saltwater at depth spreading to Heron Rookery and Freezeout Creek. Warmer conditions at the fresh/salt interface. Becoming anoxic at depth.
	T: Warm, increasing	T: Warm, increasing	T: Warming during peak summer air temperatures	
	DO: Hypoxic/anoxic at depth	DO: Hypoxic/anoxic at depth	DO: Hypoxic/anoxic at depth	
4 Weeks after closure	S: Stratified, decreasingly oceanic at mid-depth	S: Stratified, decreasingly oceanic at mid-depth	S: Stratified, increasingly brackish at mid-depth	Saltwater leaving lower Estuary by seepage. Saltwater reaching Browns Pool. Still anoxic at depth and warmer at the fresh/salt interface throughout Estuary.
	T: Warm	T: Warm	T: Warming during peak summer air temperatures	
	DO: Anoxic at depth	DO: Anoxic at depth	DO: Anoxic at depth	

NOTES: ‘S’ refers to salinity, ‘T’ refers to temperature, ‘DO’ refers to dissolved oxygen’.

As part of the *Assessment of Russian River Estuary Water Quality Monitoring to Inform Salmonid Habitat Scenarios*, Sonoma Water worked with ESA, NOAA, and UC Davis on a series of technical tasks to understand how water quality conditions affect salmonid habitat in the Russian River Estuary.[154,155,156,157] Outside of regulatory requirements and the *2008 Biological Opinion*, Sonoma Water contracted with BML for collection and evaluation of data relating to estuarine hydrodynamics (e.g., circulation), water quality, and physical processes associated with river mouth conditions. Sonoma Water also contracted with ESA to evaluate coastal and estuarine dynamics that influence river mouth conditions and estuarine rearing habitats for listed steelhead. The *Russian River Water Quality Modeling to Inform Time-Dependent Availability of Estuarine Habitat for Salmonids Project* developed additional resources needed to synthesize and evaluate temperature and dissolved oxygen data and develop a conceptual model to forecast water quality conditions under natural and managed estuarine scenarios for the benefit of listed steelhead in the Russian River Estuary. The project team, comprised of Sonoma Water, BML, and ESA, along with the NMFS, NOAA Southwest Fisheries Science Center (Santa Cruz, CA), CDFW, and the University of Washington School of Aquatic and Fishery Sciences, successfully developed a conceptual model (“Habitat Browser” or “Habitat Viewer”) to quantify the volume of available salmonid habitat changes based on water quality parameters associated with estuarine and river mouth conditions.

This work included several tasks:

- Boughton et al. (2017) reviewed existing literature, focusing on juvenile steelhead behavioral and physiologic responses to various estuarine conditions.[158] The study characterized the interconnected roles of foraging opportunity, predation risk, and the physiological impacts of water quality on juvenile steelhead rearing and growth potential. Based on fish habitat studies in lab settings, other lagoons, and the Russian River, the technical memo developed a rating scheme that identified how changes in water temperature, salinity, and dissolved oxygen affect rearing potential for both freshwater-acclimated and marine-acclimated juveniles. The rating scheme provided a qualitative approach for assessing three water quality components that are important determinants of habitat. It is intended to aid resource managers in interpreting the complex output of physical estuary models and point the way toward more focused development of coupled behavioral-bioenergetics models of salmonids rearing in estuaries. Such models will need to address the spatial and temporal structure of the tradeoffs, as well as the important role of induced physiological tolerance for salinity and hypoxic conditions as they relate to strategies for feeding, growth efficiency, and predator avoidance.

- BML developed a Habitat Viewer tool,[159] to visualize boat-based water quality data in the Estuary. This tool combines observed bathymetry and 2D water quality conditions with the steelhead habitat rating scheme of Boughton et al. (2017) to quantify the amount, quality, and

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[154] Environmental Science Associates (ESA), 2019. Russian River Estuary Water Quality and Habitat Modeling for Salmonids. Prepared for Sonoma Water.

[155] Environmental Science Associates (ESA). 2023. Russian River Estuary Adaptive Beach Management Plan. Prepared for Sonoma County Water Agency by ESA with Bodega Marine Laboratory, University of California at Davis. May 23, 2023.

[156] Environmental Science Associates (ESA). 2021a. Russian River Estuary Habitat Focus Area Phase 2: Habitat Scenarios and Data Analysis. Prepared for Sonoma County Water Agency. August, 2021. 55p

[157] Largier, 2021. *Op. cit.*

[158] Boughton, et al. 2017. *Op. cit.*

[159] Boughton, et al., 2017. *Op. cit.*

location of salmonid habitat in the Estuary under a range of scenarios.[160] Outputs of the model include two-dimensional maps of the Estuary depicting water quality suitability.

- ESA (2019) worked with BML, NOAA and Sonoma Water to develop characteristic hydrologic scenarios for the Estuary (capturing the range of observed conditions after 2009). These were used to segment the management season into common phases, each associated with its own salmonid habitat conditions (e.g., major differences may occur between spring and fall months, between inlet states, and between different river discharge rates). More recently, ESA (2021b) and Largier (2021) used the available water quality monitoring data to examine how conditions vary among these scenarios.
- ESA assessed water level data from the Jenner Visitor Center and USGS Highway 1 gages, to better understand tidal water level ranges in the Estuary.
- Habitat Blueprint funding was also directed to Sonoma Water and USGS for expansion of its sea level rise and coastal storm model (CoSMoS) for the Sonoma and Mendocino coast from Bodega Bay to Point Arena, including the Russian River Estuary from the Pacific Ocean upstream to Duncans Mills and the Russian River upstream to Guerneville. This model was intended to inform flood risk assessments in Estuary management efforts for both open and closed river mouth conditions. The results from these model scenarios were incorporated into coastal flood risk mapping on the Our Coast, Our Future (OCOF) web platform by Point Blue Conservation Science. The project also proposed to develop a coastal and watershed/basin model that would link CoSMoS coastal flood scenarios data with data depicting watershed and tributary flow to produce an integrated coastal-watershed model. This effort partnered USGS with NOAA line offices including the National Weather Service and the Office of Oceanic and Atmospheric Research (OAR). The project's primary team, comprised of the U.S. Geological Survey (USGS; Santa Cruz, CA), NOAA's Office for Coastal Management (Oakland, CA), NOAA's Fisheries Restoration Center (Santa Rosa, CA), Point Blue Conservation Science, and Sonoma Water, developed a high-resolution model of the Russian River Estuary and Sonoma Coast that is now being used to inform coastal and estuarine planning projects regarding future sea level rise and coastal storm events influenced by climate change.

4.3.7.10 Biological Monitoring

The Russian River Biological Opinion RPA 2 specifies protocols for estuarine invertebrate, fish, and water quality monitoring. Water quality monitoring is described in the Biological Opinion and in *Water Quality Monitoring Plan for the Russian River Estuary Management Project.*[161] The purpose of the monitoring described in the *2008 Biological Opinion* is to understand baseline (tidally-influenced) conditions during the lagoon management period (May 15 to October 15) and to monitor changes in water quality parameters, salmonid rearing habitat and distribution, and invertebrate distribution and abundance as they relate to adaptive sandbar management and associated summer lagoon conditions.

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[160] Note that while this work was focused specifically on steelhead, there may be some aspects that could apply to Coho and Chinook salmon, and a future study could expand this work to include several species.

[161] SCWA. 2016. Water Quality Monitoring Plan for the Russian River Estuary Management Project. June 2016.

Habitat Conditions

Habitat conditions for salmonids are dependent, in part, on water quality conditions. Water quality characteristics critical to fish habitat within the Estuary include temperature, DO, and salinity. The distribution of fish in the Estuary is, in part, based on preference for or tolerance to salinity for a given species and life stage. Under open Estuary conditions, juvenile steelhead experience primarily brackish and saline water in the lower and middle reaches and warm freshwater in the upper reach, whereas under closed Estuary conditions steelhead experience warm freshwater in the middle and upper reaches. During closed conditions, juvenile steelhead display behavior that suggested the ability to mediate stressful environmental conditions; specifically, they respond to closed conditions by moving greater distances and aggregating near thermal refugia. The borders between these habitat zones and the fish communities utilizing them are not distinct and instead form a gradually shifting continuum in response to changes in water quality characteristics related to instream flows, tidal cycles, barrier beach formation and beach management practices.

Invertebrate Monitoring

Invertebrate Prey Monitoring, Salmonid Diet Analysis, and Juvenile Steelhead Behavioral Monitoring

The monitoring of invertebrate productivity in the Estuary focused primarily on epibenthic and benthic marine and aquatic arthropods within the classes Crustacea and Insecta which serve as the primary prey for juvenile salmonids, especially steelhead. Based on the hypothesis that both diet and behavior of juvenile salmonids will vary as a function of increased water level and rearing space when the Estuary inlet is closed, the potential effects of available prey densities on diet composition and consumption rate are being compared between open and closed Estuary conditions. Sonoma Water contracted with the University of Washington, School of Aquatic and Fishery Sciences’ Wetland Ecosystem Team (UW-WET) to conduct studies of the ecological response of the Estuary to natural and alternative management actions associated with the opening and closure of the Estuary mouth. Sampling for fish diet and prey availability was designed to coincide with established beach seining sites in the lower, middle, and upper reaches of the Estuary during the Lagoon Management Period (May 15 to October 15).

Sonoma Water implemented ten years (from 2010 to 2019) of extensive aquatic invertebrate research for the Russian River Estuary Management Project. Monitoring reports were completed annually, including a summary and synthesis report of the decadal dataset and findings.[162] This report provides a long-term analysis and summary of several independent studies related to salmonid diet, prey availability, juvenile steelhead distribution and behavior, and comparison of invertebrate composition and steelhead performance in the Russian River Estuary relative to other Pacific coast estuaries. In addition, these studies evaluated the response of invertebrates and steelhead to changing river mouth conditions. The scope of many of these studies are beyond the

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[162] Accola, K. 2021. EMP Juvenile Salmon Diet and Prey Availability. Wetland Ecosystem Team – School of Aquatic Fishery Sciences, Univ. of Washington.

requirements stated in the *2008 Biological Opinion*. Scientific journal articles and graduate theses/dissertation produced from Russian River Estuary invertebrate research are listed below.

- Fuller, J. A. 2011. Extended residency and movement behavior of juvenile steelhead (*Oncorhynchus mykiss*) in the Russian River Estuary, California. Master's thesis. Humboldt State University.
- Seghesio, E. E. 2011. The influence of an intermittently closed, Northern California estuary on the feeding ecology of juvenile steelhead (*Oncorhynchus mykiss*) and Chinook Salmon (*Oncorhynchus tshawytscha*). Master's thesis. University of Washington, School of Aquatic and Fishery Sciences.
- Matsubu, W. C., C. A. Simenstad, and G. E. Horton. 2017. Juvenile steelhead locate coldwater refugia in an intermittently closed estuary. Transactions of the American Fisheries Society 146:680–695.
- Matsubu, W. C. 2019. Tradeoffs of juvenile steelhead (*Oncorhynchus mykiss*) rearing in an intermittently closed estuary, northern California USA. PhD dissertation. University of Washington, School of Aquatic and Fishery Sciences.

Spatial Distribution, Composition, and Relative Abundance of Invertebrates

Invertebrate composition showed differences between and among the three reaches of the Estuary that appeared to follow longitudinal water conditions transitioning from full-strength seawater in the lower reach to freshwater in the upper reach. However, the invertebrates that are important prey for juvenile steelhead were relatively consistent during a decade of study, (see below for more details). Epibenthic sampling indicated a somewhat distinct invertebrate prey community composition between the River Mouth and the Penny Point sampling sites in the lower reach (Figure 4-13). Additionally, sampling showed distinct prey assemblages between the upper reach at Freezeout Bar site versus the lower reach and assemblages at the Willow Creek site in the middle reach. Presumably, salinity distribution is an important factor shaping these distinctions, but the influences of tidal exchange, substrate, or other factors cannot be ruled out.

Salmonid Diet and Invertebrate Response to River Mouth Closure

Prey composition and densities in the Estuary were relatively comparable over the ten years of study, implying a relatively consistent estuarine prey community available for juvenile steelhead despite some variability in the occurrence and duration of freshwater outflow and Estuary closure events. The supplemental epibenthic sled sampling along the inundated shoreline during continued Estuary closures suggested no recognizable gradient or differentiation in the composition and relative density distribution of preferred prey. This would suggest that within the three Estuary reaches (lower, middle, upper) there was uniform or a relatively minor gradient of prey density distribution from the deeper channel to the shallow margins that flood during Estuary closures.

There was no significant change detected in the composition of juvenile steelhead diets during Estuary mouth closures. Juvenile steelhead consistently fed on common prey taxa over an inter-annual timespan. Spatial variation among Estuary reaches accounted for prey differences more than temporal variation or variation due to inlet condition. Prey distributions are consistently organized along a salinity gradient (primarily distinguishing the upper reach of the Estuary dominated by freshwater river flows); however, prey composition was consistent within the three Estuary reaches (lower, middle, and upper) regardless of inlet condition.

The growth of individually-PIT-tagged and recaptured juvenile steelhead in the Estuary rivals the highest in the literature both in natural environments and under laboratory conditions.[163] This finding is supported by a bioenergetics model investigating the relationship of diet composition and water temperature.[164] Therefore, the high growth rates of juvenile steelhead suggest that prey abundance is not a limiting factor for growth of juvenile steelhead residing in the Estuary. Simulated growth rates under open and closed mouth conditions suggest that fish grow fast enough to reach the size for increased marine survival during open and closed mouth conditions, as along as fish can find habitat below 22° C.[165] In the upper Estuary, out-migrating juvenile steelhead typically have a few weeks to rear before temperatures reach this threshold. This warming period early in the season may benefit steelhead as it provides opportunity for fish to move into the lower reaches and possibly acclimate to the saline conditions while in the cooler temperatures of the lower Estuary. This is supported by the lack of recaptures in the upper Estuary during the warmest periods. Although rising temperatures during mouth conditions may threaten rearing steelhead, changes in estuarine hydrology during these periods can provide compensation. For example, stratification and reconnection to intermittent tributaries during closures provides juvenile steelhead increased opportunities to behaviorally mediate high temperatures when less stressful temperatures are available.[166]

Diet composition of both juvenile steelhead and Chinook Salmon in the Estuary indicated that these fish feed on relatively few taxa of aquatic invertebrates, consisting of epibenthic crustaceans and aquatic insects, that are common in the Estuary. In addition, there was a persistent uniformity in juvenile steelhead foraging on epibenthic prey. Accola et al. (2021) concluded that "our results and related accounts from other intermittent estuaries in the region indicates that juvenile salmonid feeding ecology in the Estuary is of relatively modest diversity and remarkably consistent. Thus, their feeding should be predictable as long as the spectrum of available prey is not dramatically altered…and…these prey taxa are reported to be common components in juvenile steelhead (and Chinook Salmon, in a few cases) diets in other intermittent systems estuaries along the California coast."[167]

Conclusions

The invertebrate studies in the Estuary were able to quantify and determine several characteristics of the invertebrate community and their importance as prey for rearing juvenile steelhead, which are listed below.

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[163] https://www.sonomawater.org/reports

[164] Seghesio, E. E. 2011. The influence of an intermittently closed, Northern California estuary on the feeding ecology of juvenile steelhead (Oncorhynchus mykiss) and Chinook salmon (Oncorhynchus tshawytscha). Master's thesis. University of Washington, School of Aquatic and Fishery Sciences.

[165] Matsubu et. al., 2019. *Op. cit.*

[166] Matsubu et. al., 2017. *Op. cit.*

[167] Accola, K. 2021. *Op. cit.*

- The annual composition and abundance of invertebrates in the Estuary were similar across the ten years of study, implying a relatively consistent prey base for juvenile steelhead.
- Invertebrate distributions were consistently organized along a salinity gradient from seawater at the river mouth to freshwater at the upstream end of the Estuary.
- Invertebrate composition was consistent within the three reaches of the Estuary regardless of inlet condition.
- During inlet closures leading to the formation of a lagoon that inundated the shoreline, the density and distribution of invertebrates in the newly created marginal habitat was similar to the adjacent deeper channel.
- Juvenile steelhead consistently fed on relatively few taxa of common aquatic invertebrates consisting of epibenthic crustaceans and aquatic insects.
- The diet of juvenile steelhead did not appear to change based on inlet condition.
- The high growth rates of juvenile steelhead suggest that prey abundance is not a limiting factor for rearing steelhead survival in the Estuary.

Salmonid Monitoring

Sonoma Water has addressed the salmonid monitoring objectives outlined in the *2008 Biological Opinion* through a combination of:

- Beach seining at standard sites throughout the length of the Estuary.
- PIT-tagging juvenile steelhead at downstream migrant traps upstream of the Estuary.
- Subsequent PIT tag detections of juvenile steelhead at the upstream end of the Estuary and during beach seining sampling.

Beach Seining

Sonoma Water has been fish sampling the Russian River Estuary since 2004, prior to issuance of the *2008 Biological Opinion*. An Estuary fish survey methods study was completed in 2003.[168] The Estuary fish seining monitoring area included the tidally-influenced section of the Russian River and extended from the sandbar at the Pacific Ocean to Duncans Mills, located 9.8 rKm upstream from the coast. A beach-deployed seine was used to sample fish species, including salmonids, aimed at estimating their relative abundance and distribution within the Estuary.

Marine and estuarine species were commonly found in the lower reach: including topsmelt (*Atherinops affinis*), surf smelt (*Hypomesus pretiosus*), and staghorn sculpin (*Leptocottus armatus*). The middle reach had a broad range of salinities and a diversity of fish tolerant of these conditions. Common fish in the middle reach included those found in the lower reach plus shiner surfperch (*Cymatogaster aggregata*) and bay pipefish (*Syngnathus leptorhynchus*). Freshwater dependent species, such as the Sacramento sucker (*Catostomus occidentalis*), Sacramento pikeminnow (*Ptychocheilus grandis*), and Russian River tule perch (*Hysterocarpus traskii pomo*) were predominantly distributed in the upper reach. Anadromous fish, such as steelhead

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[168] Cook, D. 2004. Russian River Estuary Flow-Related Habitat Project – Survey Methods Report. June 2004.

(*Oncorhynchus mykiss*) and American shad (*Alosa sapidissima*), which can tolerate a broad range of salinities, occurred throughout the Estuary. Habitat generalists, such as threespine stickleback (*Gasterosteus aculeatus*) and prickly sculpin (*Cottus asper*), occurred in abundance throughout the Estuary, except within full-strength seawater in the lower reach.

Downstream Migrant Trapping

The RPA in the *2008 Biological Opinion* includes information gathered by Sonoma Water about the timing of downstream movements of juvenile steelhead into the Estuary, their relative abundance, and the size/age structure of the population as related to the implementation of an adaptive management approach to promote formation of a perched freshwater lagoon. The sampling design implemented by Sonoma Water and described in this section specifically targets the detection and capture of anadromous salmonid young-of-the-year (YOY, age-0+) and parr (≥age-1) (collectively referred to as juveniles) as well as smolts. To help accomplish the objectives listed above, Sonoma Water captured and PIT-tagged fish at selected trapping sites upstream of the Estuary:[169]

- Mainstem Russian River at Mirabel (rkm 39.6)
- Mark West Creek (confluence at rkm 38.7)
- Dutch Bill Creek (confluence at rkm 16.5)
- Austin Creek (confluence at rkm 11.6)
- Dry Creek (capture only, included for broader sampling context) (confluence at rkm 52.0)

Stationary PIT antenna arrays were operated in the following locations:

- Upstream end of the Russian River Estuary in Duncans Mills (rkm 10.46)
- Near the mouth of Austin Creek (0.5 km upstream of confluence)

Conclusions

Juvenile steelhead movement to the Estuary from most tributaries for rearing can only occur in spring when tributaries are connected to the mainstem Russian River and when river water temps are cool. Otherwise, there is a physical and/or thermal barrier for steelhead movement in the summer. Therefore, unless juvenile steelhead make their way into the Estuary during the spring, they will not have access to the Estuary and will therefore be unable to capitalize on the growth opportunity afforded by the Estuary (whether the mouth is open or closed). While there are individuals that rear in the Estuary throughout the summer, the margin of benefit in terms of growth from a closed mouth condition as compared to an open condition is not apparent from available empirical data on invertebrate prey composition or individual-based growth of juvenile steelhead.

- A much higher proportion of young-of-the-year steelhead captured at the Austin Creek downstream migrant trap were detected entering the Estuary between 2010 and 2017

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[169] See Section 5.8.2, *Biological Opinion Monitoring* in particular Figure 5-6.

(mean=60%)[170] as compared to fewer than 1% from other downstream migrant trapping locations during the same period.

- Juvenile steelhead movement to the Estuary can only occur in spring when tributaries are connected to the mainstem Russian River and when river water temps are cool.[171]
- Mean catch-per-unit-effort of juvenile steelhead from beach seining between 2009 and 2021 was less than 0.4 fish per seine set with a general pattern of larger-sized fish tending to reside in the lower Estuary where salinity is higher and water temperatures are cooler.[172]
- Mean growth rates of juvenile steelhead rearing in the Estuary during summer exceed 1 mm per daywhich is as high as or higher than the observed rates in the comparable literature.[173,174] These high growth rates are likely related to the increased ability of fish to osmoregulate in saltwater as they grow.[175]

4.4 Dry Creek Watershed

The Dry Creek watershed drains 562 km^2 from the interior Coast Ranges of northern Sonoma and southern Mendocino counties before entering the Russian River near the City of Healdsburg, 48 km upstream of the Pacific Ocean.[176] The northwest-trending watershed is 51 km long and 11 km across at its widest point, with elevations ranging from 3,000 feet at the drainage divide to 70 feet near the confluence with the Russian River. Dry Creek is the second largest tributary by area within the Russian River watershed, but contributes the largest amount of annual runoff. Current land use is dominated by agriculture (viticulture), but historical land use still influences the landscape. Past practices include forest clearing for grazing and agriculture, gravel and sand excavation, and channel straightening and levee construction for flood control.

Warm Springs Dam bisects and controls the upper 339 km^2, approximately 60 percent of the watershed. The dam is located 22.5 km upstream from the confluence of Dry Creek with the Russian River and releases are jointly operated by the USACE for flood control and by Sonoma Water for water supply. Terrain upstream of the dam is steep and mountainous, with hillslopes exceeding 30 percent and channel slope ranging from 0.2 to 4 percent. Downstream of the dam, Dry Creek flows through a flat, relatively narrow alluvial valley with a channel slope ranging from 0.2 percent downstream near the Russian River to greater than 2 percent upstream near the dam.[177] Major tributaries to Dry Creek upstream of the dam are Cherry and Warm Spring creeks. Similar to Coyote Valley Dam, construction of Warm Springs Dam altered watershed hydrology

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[170] Martini-Lamb, J. and Manning, D. J., editors. 2020. Russian River Biological Opinion Status and Data Report Year 2017. Sonoma County Water Agency, Santa Rosa, CA. 401 p.

[171] Based on an analysis of average daily water temperature at Hacienda Gage (approximately 11.4 km upstream of the mouth of Austin Creek) since 2013 when the Duncans Mills PIT antenna was installed, the mainstem exceeds 20° C by June 1 more than 75% of the time.

[172] Due to the large size of the Estuary coupled with the fact that steelhead are highly mobile, beach seining can be hit or miss and therefore does not provide an adequate measure of juvenile salmonid density.

[173] Matsubu et. al., 2019. *Op. cit.*

[174] https://www.sonomawater.org/reports

[175] Boughton, et al., 2017. *Op. cit.*

[176] Harvey, M.D. and Schumm, S.A. 1985. *Op. cit.*

[177] Inter-Fluve, 2010. Final Current Conditions Report, Dry Creek from Warm Springs Dam to the Confluence with the Russian River. Prepared for Sonoma Water. December.

by reducing peak flows during wet periods and increasing baseflow during dry periods. Dam emplacement also interrupted sediment transport, leading to incision and bed coarsening downstream of the dam.[178]

4.4.1 Hydrology

Tributaries contributing the majority of flow and sediment to Dry Creek below Warm Springs Dam include Fall, Dutcher, Peña, Grape, Crane, and Mill creeks (**Table 4-9**). Fall and Dutcher creeks enter Dry Creek approximately 2.4 km downstream of Warm Springs Dam from the west and north respectively, and Peña Creek enters approximately 4 km downstream from the west, all are upstream of Yoakim Bridge. Grape and Crane creeks enter just upstream and downstream of Lambert Bridge from the southwest. The largest tributaries by drainage area are Pena Creek (60 m^2), which joins Dry Creek at rkm 18, and Mill Creek (57 km^2), which enters from the southwest near the confluence with the Russian River.

TABLE 4-9
MAJOR TRIBUTARIES TO DRY CREEK

Tributary	Drainage Area (km^2)	Dry Creek River Kilometer (rkm)
Fall Creek	5	19
Dutcher Creek	8	19
Pena Creek	60	18
Grape Creek	8	11
Crane Creek	5	10
Mill Creek	57	2

SOURCE: USACE, 1982. Northern California Streams Investigation: Russian River Basin Study. San Francisco, Ca. 231 pp.

There are three gages along Dry Creek from Warm Springs Dam to the Russian River confluence with varying periods of record and seasonal operation (**Table 4-10**). Focusing on the gage with the longest period of record (Dry Creek near Geyserville, USGS Gage No. 11465200) median monthly flow shows characteristics that are similar to the upper Russian River. Instream flow is greatest during late-fall and early winter and lowest from summer to early-fall. The median mean monthly flow is greatest in March and lowest from May through October. This pattern is consistent with the Mediterranean climate and regulation by Warm Springs Dam. The period of record for this stream gage (October 1959 to present) encompasses pre- and post-dam hydrologic conditions. Before regulation (i.e., before the closure of Warm Springs Dam in 1984), surface flow in Dry Creek typically peaked in February and nearly disappeared from June to October. Dam operations muted peak flows (compared to unregulated conditions) and released a consistent summer flow, which reflects the flood control and water supply functions of WSD. Based on a review of WSD release and downstream gage data, during the wet season (November through May), runoff from tributaries accounts for most of the flow in Dry Creek. During the dry season, most of the flow in Dry Creek consists of water released from Lake Sonoma.

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[178] USACE, 1987. Dry Creek sediment engineering investigation: sediment transport studies. Sacramento, CA.

TABLE 4-10
USGS FLOW GAGES ALONG DRY CREEK

Gage Name	Gage No.	Drainage Area (km^2)	Period of Record
Dry Creek near Geyserville	11465200	420	1959-present
Dry Creek near Lambert Bridge	11462080	453	2011-present
Dry Creek near Healdsburg	11465350	562	1981-present

SOURCE: SCWA, 2016. Fish Habitat Flows and Water Rights Project Draft Environmental Impact Report. July 2016.

4.4.2 Geomorphology

The current geomorphic condition of Dry Creek reflects changes in type and intensity of land-use practices. Harvey and Schumm (1985) conducted a geomorphic assessment of Dry Creek that described cross-sectional and longitudinal response to changes in land-use since 1850, the beginning of European settlement.[179] Prior to 1850, forests covered 50 percent of the Dry Creek basin.[180] Settlers cleared up to 40 percent of these forests for grazing, resulting in increased surface and hillslope erosion and sediment delivery to the stream channel. This land-use change also increased stream discharge through decreases in infiltration and more efficient delivery of runoff from agricultural drainage systems. The channel responded by aggrading up to 3 feet, then degrading approximately 12 feet to reach an equilibrium base-level by 1900. The onset of gravel mining from the channel and floodplains in the Russian River and Dry Creek caused further channel degradation. By 1964 the Dry Creek channel incised another 10 feet, resulting in channel instability and increased sediment yield to the Russian River. The rate of channel incision decreased by 1974, with Harvey and Schumm (1985) noting further degradation (2.4 feet) from the 1964 base-level. However, the systemic incision ceased just upstream of Lambert Bridge due to the presence of grade controlling Franciscan Foundation bedrock outcrops. By 1984, Dry Creek downstream of Lambert Bridge lowered another 2 feet, but appeared to reach a new equilibrium with the formation of a sinuous channel and adjacent gravel bars within the recently incised valleys.

At present, the primary determinant of current geomorphic conditions is the influence of the dam, expressed through modified sediment supply, altered hydrology and the growth of riparian vegetation. Dam construction ceased delivery of bed material from the upper 60% of the watershed. The hydrologic regime has been converted from a seasonal runoff-based regime to a regime that combines moderate winter floods, year-round flows, and sustained, relatively high baseflow conditions. The change in hydrology has also resulted in increased growth of riparian trees that influence bank erosion rates.[181,182]

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[179] USACE, 1987. Dry Creek sediment engineering investigation: sediment transport studies. Sacramento, CA.

[180] Ritter, J.R. and Brown, W.H. 1971. Turbidity and Suspended Sediment Transport in the Russian River Basin, CA. Prepared in Cooperation with USACE, Menlo Park, CA.

[181] Inter-Fluve, 2011. Dry Creek Habitat Enhancement: Feasibility Study (Draft Report, July 2012). Prepared for Sonoma County Water Agency, Santa Rosa, CA.

[182] Inter-Fluve, 2012. Final Habitat Enhancement Feasibility Study Report, Dry Creek from Warm Springs Dam to the Confluence with the Russian River. Prepared for Sonoma Water. December.

The reduction in bedload supply is most noticeable in the reach between the dam and the confluence of Dutcher and Pena Creeks. The reduction in bed material supply is moderated by successive tributaries entering lower Dry Creek. The most significant of these in terms of bed material supply include Dutcher Creek, Pena Creek, Crane Creek and Mill Creek. The reach between Pena Creek and Westside Bridge does not appear to be actively incising or aggrading, though there are selected areas of active channel adjustment. The reach between Westside Bridge and the confluence appeared to be the most alluvial reach, in which the channel position and shape are most readily shaped by fluvial forces.[183]

Regulation has resulted in elevated summer baseflow conditions that when combined with the Mediterranean climate produces near ideal conditions for growth of riparian trees and shrubs. Regulation has also resulted in severe curtailment of major floods, which limits disturbance and removal of newly recruited and established vegetation. This combination of effects has resulted in extensive vegetative colonization of formerly active bar surfaces. Colonization of the bar surfaces serves to limit lateral migration of the active channel within the channel corridor, and has the effect of sequestering a reservoir of gravel within the system.[184]

Vegetative colonization of bar surfaces has also led to an active channel that is efficient at moving gravel supplied to the stream despite the reduced flood flow hydrology. Mature vegetation and dense understory growth hydraulically roughen over bank areas and concentrate high flow velocities in the channel during high flow events. However, based on field observations, the combination of reduced bed material supply and reduced flood magnitudes and frequencies do not appear to have resulted in incremental systemic degradation or aggradation though areas of local adjustment and bed degradation are apparent, as observed by long-time Dry Creek landowners. Degradation is also kept in check by features which control the bed grade spaced periodically over the reach, such as bedrock exposures and grade control structures.

4.4.3 Dry Creek Channel Maintenance

Channel improvements at 15 sites along Dry Creek were built by USACE between 1981 and 1989 as part of the WSD and Lake Sonoma Project. The improvements include three rock-type grade-control structures, 5,800 feet of riprap bank protection, and flow-deflection fences. These improvements were intended to provide bank and riverbed stabilization at sites where erosion previously occurred or where studies indicated that future erosion was likely, due to the construction and operation of WSD. Maintenance responsibility for the channel stabilization project lies with Sonoma Water, as established by an agreement between Sonoma Water and USACE in June 1988. USACE provided Sonoma Water with the *Warm Springs Dam and Lake Sonoma Project, Russian River Basin, Dry Creek Channel Improvements, Sonoma County, California Operation and Maintenance Manual*.[185] This manual provides information, instruction, and guidance to the personnel responsible for proper operation, inspection, and maintenance of channel improvements and bank stabilization measures along Dry Creek

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[183] Inter-Fluve, 2012. *Op. Cit.*

[184] Inter-Fluve, 2012. *Op. Cit.*

[185] USACE, 1991. Warm Springs and Lake Sonoma Project Russian River Basin, Dry Creek Channel Improvements Sonoma County, California: Operation and Maintenance Manual. Sacramento District. July.

downstream of WSD. This includes maintenance work associated with these sites involving incidental sediment removal, vegetation management, debris removal, and bank stabilization to ensure the structural integrity of the improvements. In 2018, one of the rock-type grade-control structures was removed by the USACE as part of the Dry Creek habitat enhancement efforts associated with the *2008 Biological Opinion*. Outside of the work done on the remaining 14 channel improvement sites in Dry Creek, additional vegetation removal for flood control or bank erosion has not been performed in Dry Creek by Sonoma Water or USACE since the issuance of the *2008 Biological Opinion*.[186]

4.4.4 Dry Creek Habitat Enhancement

The *2008 Biological Opinion* includes RPA elements designed to mitigate effects of Sonoma Water and USACE operations in the Russian River watershed on salmonids. One of these RPA elements requires six (6) miles of lower Dry Creek habitat enhancements, contained within the 13.9-mile stretch between WSD and the Russian River confluence, to create both winter and summer rearing habitats for juvenile steelhead and Coho Salmon. The six miles of habitat enhancements are designed to emphasize natural stream characteristics and include design elements such as backwater channels, alcoves and ponds, side channels, log jams, pool enhancements, constructed riffles, and riparian vegetation management. Enhancement projects were designed and implemented to address the lack of low water velocity areas with adequate cover and appropriate water depth that limit habitat suitability for juvenile salmonids in general, and juvenile Coho Salmon in particular. Success of these enhancements is determined through three stages of monitoring: (1) implementation monitoring to determine if the habitat enhancement was done according to the approved design, (2) effectiveness (habitat) monitoring to determine if the enhancement is having the intended effect on physical habitat quality, and (3) validation (fish) monitoring to assess whether the habitat enhancement is achieving the intended biological objective.

The Dry Creek enhancement RPA delineated a five-phase approach to construction. While the timing of these steps has been revised relative to the *2008 Biological* Opinion, the general approach outlined below remains unchanged:

1. Two years of conceptual project design and planning (2009-2010);
2. Two years for project review, permitting, and pre-monitoring (2011-2012);
3. Two years of initial construction (demonstration reach) of at least one mile of modified stream channel (2013-2014);
4. Two years of construction (covered by the *2008 Biological Opinion*) of an additional two miles of modified stream channel (2016-2021); and
5. Three years of construction (covered until September 2023 by the *2008 Biological Opinion* and a future Biological Opinion) of an additional three miles of modified stream channel (2022-2025).

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[186] A concrete sill was removed as part of the USACE Continuing Authorities Program (CAP) 1135 project in 2018.

Part of the conceptual design, permitting, and pre-monitoring efforts (Steps 1 and 2, above) included the following feasibility studies:

- A summary of watershed context and hydrology; including an assessment of stream geomorphology based on available data and field observations, and a detailed summary of the fish habitat inventory.[187]
- An initial feasibility study and conceptual design report describing and outlining potential enhancement opportunities within Dry Creek.[188,189]
- A quantitative assessment of stream geomorphology and trajectory; including an analysis of the feasibility of fish habitat enhancement to meet the habitat goals of the *2008 Biological Opinion*.[190]
- A delineation of enhancement reaches; including the development of conceptual designs for habitat enhancement within each of these reaches (**Table 4-11**).[191]

The conceptual design report for the enhancement projects included the delineation of 15 reaches (25 including sub-reaches) within Dry Creek. Each of these reaches was ranked on their potential ecological benefit to rearing Coho Salmon and steelhead. Evaluation metrics include potential for and potential amount of summer and winter refuge habitat and the predicted continuity of habitat benefits. Each reach was then evaluated alongside other limiting factors including access, cost, and overall distribution along Dry Creek to develop a prioritized list of enhancement locations.

The first of these enhancement projects (Demonstration Project) was completed in November 2014 in reach 7. Concurrently, the USACE completed construction of an enhancement project within Reach 15, immediately below Warm Springs Dam. Together, the Sonoma Water's demonstration project and the USACE's reach 15 project make up just over one mile of modified stream channel work to improve habitat for listed salmonid species in Dry Creek. In 2016, Sonoma Water began construction of miles two and three, through the enhancement of instream habitat approximately one mile upstream of the demonstration project (subreach 8b) and within a downstream reach of the creek just below the Westside Road Bridge crossing (subreach 2b). Construction within both reaches was completed during 2017. In 2018, following completion of these projects, Sonoma Water started construction of an additional enhancement project within reach 14; while USACE implemented a project within subreach 4a. The USACE work in subreach 4a was completed in 2018, and Sonoma Water's reach 14 work was completed in 2019. In 2020, Sonoma Water started construction of the remaining portions of enhancement miles two and three through the construction of a project within subreach 5a. The subreach 5a construction work was completed in 2021. Descriptions of the enhancement projects are contained below and the locations shown on **Figure 4-14**.

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[187] Inter-Fluve, 2010. *Op. cit.*

[188] Inter-Fluve, 2011. *Op. cit.*

[189] Inter-Fluve, 2012. *Op. cit.*

[190] Inter-Fluve, 2012. *Op. cit.*

[191] Inter-Fluve, 2012. Dry Creek Fish Habitat Enhancement: Conceptual Design Report, Dry Creek from Warm Springs Dam to the Confluence with the Russian River. Prepared for Sonoma Water. July.

Figure 4-14
Dry Creek Enhancement Project – Reaches and Timeline

TABLE 4-11
DRY CREEK ENHANCEMENT REACHES

Reach/Subreach (Confluence to WSD)	Phase	Construction Completion Date	Habitat Miles Enhanced / Cumulative Enhancement
15	I (USACE)	2013	0.3 / 0.3
7	Ph I (Demonstration)	2014	0.7 / 1.0
8a	II	2016	0.3 / 1.3
8b	II	2017	0.3 / 1.6
2b	III	2017	0.3 / 1.9
14b	II	2018	0.4 / 2.3
4a	III	2018	0.3 / 2.7
14a	II	2019	0.3 / 3.0
5a	III	2021	0.3 / 3.4
10a	IV (USACE Ph 1)	2023	0.2 / 3.6
10b	IV (USACE Ph 1)	2023	0.2 / 3.8
13a	IV (USACE Ph 1)	2023	0.2 / 4.0
13b	IV (USACE Ph 1)	2023	0.2 / 4.2
4c	V (USACE Ph 2)	2023	0.3 / 4.5
5b	III	2024	0.3 / 4.8
4b	III	2024	0.2 / 5.0
2a	V & VI (USACE GI Ph 2 & 3)	2023 / 2025	0.5 / 5.4
1	VI (USACE GI Ph 3)	2025	0.4 / 6.0

NOTE: For future enhancement sites construction dates and restored enhancement lengths are approximate based on current construction schedules and designs.

SOURCE: Inter-Fluve, 2011. Dry Creek Habitat Enhancement: Feasibility Study (Draft Report, July 2012). Prepared for Sonoma County Water Agency, Santa Rosa, CA.

RPA 3 of the *2008 Biological Opinion* stipulated that Sonoma Water and USACE would complete the six miles of enhancement by Year 12 (2020) of the permit. Despite their best efforts, Sonoma Water and USACE were not able to complete the six miles of enhancement within that allotted timeframe. As described in Section 3.7, *Dry Creek Enhancement*, the remaining 2.6 miles of enhancement are still in progress and included as part of the Proposed Action. Importantly, delays in the completion were not the result of inaction on the part of Sonoma Water and USACE. Pre-construction tasks including conceptual design, permitting, pre-monitoring efforts were initiated immediately upon issuance of the *2008 Biological Opinion* but took longer than had been anticipated. In particular, the extensive time required to identify and enlist willing landowners slowed the rate at which enhancement actions could identified, designed, permitted, and eventually constructed.

4.4.4.1 Completed Enhancement Projects

Phase 1

Dry Creek Habitat Enhancement Demonstration Project (constructed 2012, 2013 and 2014)

Sonoma Water completed construction of the Dry Creek Enhancement Demonstration Project (Demonstration Project) in November 2014 within reach 7. This project consisted of a variety of enhancements along a section of Dry Creek, a little over a mile in length, centered around Lambert Bridge. In addition to addressing the habitat restoration goals outlined in the *2008 Biological Opinion*, this project was designed with the goal to demonstrate enhancement techniques that could be utilized elsewhere within Dry Creek. This project was constructed in three phases between 2012 and 2014 and included the construction of 3 backwater ponds, intended for year-round use, as well as a backwater channel for refuge habitat in the winter, placement of large wood and boulder structures, and bank stabilization including the removal of invasive plant species.

Following completion of the Demonstration Project, Sonoma Water has conducted minor maintenance and adaptive management work to address erosion and aggradation within the reach. A minor amount of erosion occurred around an engineered log jam at the outlet of a constructed backwater pond. High flows over the structure resulted in finer gravel being winnowed out from between the logs exposing the entire structure. Due to concern that the structure could present a hazard, Sonoma Water restored the structure to its original design.

Additionally, due to minor erosion in and sediment transport through an existing high-flow channel, a moderate amount of aggradation occurred at the upstream end of a constructed backwater pond on top of the outlet that brings fresh water into the pond from the mainstem of Dry Creek. The blocked conduit resulted in low DO levels in the pond, reducing the habitat potential for targeted species. To address this, Sonoma Water removed approximately 500 cubic yards of gravel to open the outlet and restore the pool volume, installed a gate on the pipe inlet, and placed willow baffles to reduce water velocities and prevent further erosion in the existing high flow channel.

USACE Reach 15 Project (constructed 2013)

In 2013, USACE completed construction of the reach 15 Project which involved the enhancement of an approximately 0.3-mile reach of Dry Creek habitat just downstream of Warm Springs Dam. This project involved construction of a secondary channel, parallel to the mainstem, to provide low-flow refuge for juvenile fish during high release periods. The channel was filled with between two and four inches of cobble and gravel substrate armoring to enhance the spawning potential within this reach. The project also included the in-channel placement of large woody debris and boulder structures. Willows and other native riparian species were also planted as part of this restoration effort.

Phases 2 and 3

When effectiveness monitoring showed that the Demonstration Project met the stated goals of the *2008 Biological Opinion*, Sonoma Water moved into the second phase of Dry Creek enhancement through the design and construction of projects designated as either Mile 2 (also referred to as Phase 2 for construction documents) or Mile 3 (or Phase 3) projects. The Mile 2 or 3 designation was differentiated by which design consultant was working on a particular reach; with reaches 8 and 14 being designed by Inter-Fluve as part of Mile 2, and reaches 2, 4, and 5 being designed by ESA as part of Mile 3. Construction within each of these enhancements is discussed below.

Reach 8 (8a constructed 2016 and 8b in 2017)

The reach 8 area is approximately 2 miles upstream of Lambert Bridge and involved the enhancement of approximately a 0.6-mile reach of Dry Creek. The reach 8 work consisted of the construction of four separate secondary channels parallel to the mainstem of Dry Creek and one mainstem constructed riffle. The secondary channels each consisted of an upstream inlet connection from Dry Creek and a downstream outlet back into Dry Creek. Large wood habitat structures were installed throughout these secondary channels. The four secondary channels consisted of one long channel (approximately 1,000-feet in length), two medium length channels (approximately 500-feet in length), and one shorter channel (approximately 200-feet in length). The constructed mainstem riffle is located at the downstream end of the reach 8 work.

Reach 14 (14b constructed 2018 and 14a in 2019)

The reach 14 area is approximately 0.5 mile downstream of WSD and involved the enhancement of approximately a 0.7-mile reach of Dry Creek. The reach 14 work consisted of the construction of three separate secondary channels parallel to the mainstem of Dry Creek and one mainstem constructed riffle. The secondary channels each consisted of an upstream inlet connection from Dry Creek and a downstream outlet back into Dry Creek. Large wood habitat structures were installed throughout these secondary channels. The three secondary channels consisted of a 1,400-foot-long channel, a 1,100-foot long channel, and a 600-foot long channel one long channel. The mainstem constructed riffle is located at the secondary channel inlet of the furthest downstream secondary channel in this reach.

Reach 2 (2a constructed 2016 and 2b in 2017)

The reach 2 area is immediately downstream of the Westside Road bridge over Dry Creek and extends for approximately 0.4 miles downstream of the bridge. The reach 2 projects consisted of the construction of two secondary channels, a backwater alcove channel, and a section of upper bank work. Large wood habitat structures were installed throughout the secondary channels and the alcove. The two secondary channels consisted of one channel approximately 550 feet in length and one channel approximately 400 feet in length. The backwater alcove is approximately 150 feet in length. The upper bank work consisted primarily of the removal of earthen berms along the top of the channel bank along a 600-foot section of the creek bank downstream of the bridge. The berms were installed at some point in the past presumably for flood protection prior to the construction of WSD. The presence of the berms disconnected the upper terrace of the property from the creek as well as obscured the views of the creek from the upper bank.

Reach 4 (constructed 2018)

USACE completed enhancement of approximately 1,700 feet of Dry Creek habitat within reach 4 in 2018. Reach 4 is bisected by a concrete grade control sill which separates the full reach into two sub-reaches: subreach 4a (habitat downstream of the sill) and subreach 4b (habitat upstream).

Within subreach 4a, USACE constructed two secondary channels, opposite each other, through existing floodplain surfaces on each side of the creek. The right-bank secondary channel is approximately 500 feet long and includes one alcove section near the upstream connection to the mainstem. The secondary channel on the left overbank (looking downstream) is approximately 1,100 feet long with upstream and downstream connections to the main channel. Log jams were constructed to provide hydraulic control at the channel connections. Additionally, one small alcove was added to the left upstream section of this secondary channel and a high flow terrace graded at the downstream end of the channel to provide off-channel refugia at high flows. Enhancement of subreach 4b consisted of construction of a secondary channel approximately 650 feet long on the left overbank.

Modifications to the lower grade control sill and existing fish ladders were also performed to improve fish passage and hydrologic connectivity. These modifications included construction of a notch to provide a connection between the two secondary channel features on the left bank and replacement of the two existing fish ladders running through the center of the grade control sill by lowering the sill and resurfacing it with riffle substrate to allow fish passage.

Following the completion of construction, the main channel through reach 4 sustained a substantial amount of aggradation during high flows events in 2019 and the creek avulsed into the constructed side channel. To address this, the aggraded main channel was excavated to re-establish a low-flow channel and willow baffles were installed to reduce flow velocities and discourage sediment movement through high-flow channels feeding into the project sites. Approximately, 3,000 cubic yards of material was removed during excavation. The majority of the flow has since shifted back into the original main channel during subsequent high flow events, restoring the constructed channel as a secondary channel as originally designed.

Reach 5 (constructed 2020 and 2021)

Reach 5a is located approximately two miles downstream of Lambert Bridge and ½ mile upstream of the three grade control sills constructed by the USACE in Dry Creek around the time of the dam installation. Reach 5a was the last remaining reach area of the Mile 2 and 3 projects to be completed, with construction finishing in 2021. Reach 5a construction entailed both in-channel enhancement, as well as the creation of side and back channels with woody debris habitat structures stabilized or anchored using boulders and driven logs. Additional enhancement elements within this reach included the creation of boulder fields, connection points to off-channel areas, the targeted felling of large trees into the margins of the constructed channels, and bank stabilization.

Constructed side channels were excavated to run parallel to mainstem Dry Creek to contain through-flows during the summer. These secondary side channels reduce the stream current, and, in conjunction with large woody structures, provide foraging, cover, and resting habitat for salmonids. These side channels also contain large woody debris structures to provide habitat and to armor potential weak points in the constructed channel. Additionally, constructed riffle complexes were installed in the channel beds to increase habitat complexity.

4.4.4.2 Fish Relocation and Dewatering

The number of fish relocated as part of Dry Creek Enhancement construction is shown below in **Table 4-12**. The table also includes other aquatic species encountered (e.g., crayfish, frogs) and the number of mortalities resulting from handling. In general, fish relocation efforts have resulted in very low mortalities for salmonids (0.6% for steelhead, no mortalities for Coho or Chinook salmon). Mortalities were mainly the result of injury/shock that occurred as a result of the capture process. Coho salmon are rarely encountered during fish rescue/relocation efforts and no Coho salmon mortalities have occurred during relocation.

TABLE 4-12
FISH AND AQUATIC SPECIES RELOCATED AS PART OF DRY CREEK ENHANCEMENT, 2012-2022

Species	Live	Mortality
Steelhead	959	6 (0.6%)
Coho salmon	3	0
Chinook salmon	2	0
Unknown salmonid	134	0
California roach	36	1 (2.8%)
Fathead minnow	1	0
Hardhead	21	0
Pacific lamprey	776	0
Western Brook Lamprey	7	0
Lamprey sp.	97	0
Sacramento pikeminnow	41	0
Sacramento sucker	725	4 (0.6%)
Stickleback	393	0
Sculpin sp.	1,069	0
Bluegill	34	0
Green sunfish	2	0
Largemouth bass	1	0
Cyprinid sp.	1	0
Crayfish	17	0
Crayfish sp.	1	0
Frog	33	0
Tadpole	4	0
Total	**4,268**	**11**

SOURCE: SCWA, 2023. D. Cuneo personal communication. August 10, 2023.

Dewatering and isolation extents within Dry Creek are shown below in **Table 4-13**. As very little of Dry Creek was completed dewatered, the numbers below also include lengths of wetted areas that were isolated from the adjacent creek. During construction, wetted areas were isolated through the use of block nets with fish then removed and relocated from these areas. Dewatering and creek isolation was primarily conducted within off-channel inlet/outlet where new side channels are connected to the mainstem, or in mainstem constructed riffles. The lengths are shown as totals by enhancement site; however, total length is typically comprised of a number of smaller dewatered/isolated sections. The lengths of these smaller reaches are shown in parenthesis.

TABLE 4-13
DRY CREEK DEWATERING AND ISOLATION AS PART OF DRY CREEK ENHANCEMENT, 2012-2022

Sites	Year	Reach	Mainstem Dewatering/Isolation	Inlet/Outlet Dewatering/Isolation	Bank Repair Dewatering
Quivira	2012	7	NA	NA	NA
Farrow-Wallace	2013	7	100' (Const. Riffle)	105' (30', 75')	NA
USACE 15	2013	15	NA	?	NA
Van Alyea	2014	7	200' (2x 100' Const. Riffles)	150' (60', 90')	500' (Mascherini bank)
Geyser Peak (2C)	2016	2	NA	100' (50', 50')	NA
Meyer (8C)	2016	8	NA	100' (40', 60')	NA
Truett (8D)	2016-2017	8	NA	70' (35', 35')	NA
City Yard (2D)	2017	2	NA	170' (60', 60',50')	NA
Lonestar (8B) and Carlson (8A)	2017	8	175' (Const. Riffle)	115' (20', 30', 30', 35')	NA
USACE CAP 1135	2018	4	90' (sill removal area)	520' (120', 45', 75', 65', 45', 40', 60', 70')	NA
Weinstock (Area H)	2018	14	NA	105' (55', 50')	NA
USACE 14 (Area J)	2018	14	NA	80' (40', 40')	NA
Gallo (Area G)	2019	14	100' (Const. Riffle)	90' (35', 25', 30')	NA
Reach 5A	2020-2021	5	NA	210' (30', 60', 40', 80')	430' (Boaz Bank)
Foley	2022	13	NA	115' (50', 65')	NA

SOURCE: SCWA, 2023. D. Cuneo personal communication. August 10, 2023.

4.4.4.3 Dry Creek Habitat Enhancement Monitoring

Given the staged approach in enhancement project implementation, the restored reaches within Dry Creek exist at different stages of effectiveness monitoring (i.e., pre-enhancement, post-enhancement, etc.). The most recent effectiveness monitoring data and reach ratings are summarized below (see **Tables 4-14** and **4-15**).

TABLE 4-14
PRIMARY AND SECONDARY HABITAT PERFORMANCE MEASURES FROM THE DRY CREEK AMP

Type of Performance Measures	Performance Measure	Life Stage	Spring Flow (200 cfs)	Summer Flow (105 cfs)	Winter Flow (1,000 cfs)
Primary	Velocity (ft/s)	Fry	0 – 0.5 ft/s	-	-
	Depth (ft)	Fry	0.5 – 2.0 ft	-	-
	Velocity (ft/s)	Parr	0 – 0.5 ft/s		
	Depth (ft)	Parr	2 – 4 ft.		
	Shelter Value	Juvenile	≥ 80		
	Pool: Riffle ratio	Juvenile	-	1:2 to 2:1	-
Secondary	Temperature (°C)	Juvenile	-	8 - 16 °C	-
	Dissolved Oxygen (mg/l)	Juvenile	-	6 – 10 mg/l	-
	Canopy (%)	Juvenile	80%		
	Quiet Water (<0.5 ft/s) (%)	Juvenile	-	-	≥ 25%
	Off-Channel Access (ft/s)	Juvenile	Approx. 1.5 – 1.8 cm/s (U_{crit}) Approx. 3.3 ft/s (burst speed)		
	Habitat Connectivity	Juvenile	Undefined		
	Substrate Particle Size (in)	Adult	-	-	0.25 – 2.5 in.
	Depth (ft)	Adult	-	-	0.5 – 1.6 ft.

SOURCE: Porter, M., D. Marmorek, D. Pickard, and K. Wieckowski, 2014. Dry Creek Adaptive Management Plan (AMP). Prepared by ESSA Technologies LTD., Vancouver, CB. Prepared for Sonoma Water.

TABLE 4-15
ENHANCEMENT REACH RATING, CRITERIA, AND FUTURE OUTCOMES

Rating	Objectives	Criteria	Unintended Effects	Future Outcome
Excellent - Good	Achieved all or most of stated reach design objectives.	All or most sites/enhancement reaches meet or exceed targeted values (>80% of sites rated Good or Excellent).	None or minimal negative unintended effects. Unintended positive effects may outweigh failure to achieve a targeted value.	Continue to monitor according to AMP.
Fair – Poor	Partially achieved most reach design objectives, or objectives not achieved were beyond reach capacity.	Some sites/ enhancement reaches did not meet targeted values (60-80% of sites/enhancement reaches rated Good or Excellent).	May have minor or major unintended negative effects that partially offset objectives or negates a targeted gain.	Develop and implement plans to correct site metric deficiencies, add sites/features or reduce total project habitat credit. Step up monitoring on sites and features exhibiting negative performance.
Fail	Many sites achieved no goals; objectives not achieved were the fault of the feature; sites/feature may be completely gone.	Many sites/ enhancement reaches did not meet targeted values (<60% of sites/ enhancement reaches rate Good or Excellent).	Few positive effects and/or unintended negative effects may be degrading to habitat and outweigh achieved objectives.	Reduce total project habitat credit, and abandon use of failed features. Revisit site potential and conceptual design priorities.

SOURCE: Porter, M., D. Marmorek, D. Pickard, and K. Wieckowski, 2014. Dry Creek Adaptive Management Plan (AMP). Prepared by ESSA Technologies LTD., Vancouver, CB. Prepared for Sonoma Water.

Effectiveness Monitoring

The RPA concluded that suboptimal water velocity, depth, and instream cover limit juvenile Coho Salmon and steelhead and suggested optimal values for these metrics as part of the RPA. The Joint Monitoring Team (JMT), consisting of representatives from NMFS, CDFW, USACE, and Sonoma Water, refined these values within the Dry Creek AMP and developed primary performance metrics linked to optimal values of for water velocity, depth, and cover. Post-construction habitat monitoring provides data which are used by which to evaluate the effectiveness of habitat features, sites, and reaches (Table 4-14). The JMT also identified secondary performance metrics that help determine the effectiveness degree to which of habitat enhancements to influence non-target habitat metrics (e.g., water temperature, dissolved oxygen concentration) and life stages (e.g., adult spawning). The AMP also suggested monitoring at a variety of target flows in order to represent seasonal variation critical to juvenile each life stages.

Quantitative and qualitative data collection to evaluate the effectiveness of the enhancement projects occurs across several increasingly broad spatial scales. This allows data collected at smaller spatial scales to be combined to allow evaluation at progressively larger spatial scales thereby allowing a robust evaluation of individual project elements in a meaningful way within each other as they increase in size:[192]

- Feature: Individually engineered elements (e.g., large woody debris accumulation, riffle, pool, side channel, alcove, boulder cluster).
- Habitat unit: A designation within a habitat classification system that allows stratification (based on natural patterns of variation) when attempting to quantify physical attributes of a stream.
- Site: An engineered portion of stream channel (e.g., side channel or alcove) constructed within an enhancement reach, or a portion of stream channel adjacent to engineered portions of stream channel (e.g., a mainstem portion of channel adjacent to a constructed side channel). Sites typically contain several features and habitat units, but in some cases may contain no features and a single habitat unit (e.g., a mainstem portion of channel with no features adjacent to constructed side channel). Sites may also contain several features, but no habitat unit, such as floodplain sites that are dry during the summer.
- Enhancement reach: A collection of sites implemented in close proximity to one another.
- Project reach: A collection of enhancement reaches implemented during the same project phase.

Quantitative and qualitative data collected at the feature- and habitat-unit-scale provide the basis to inform evaluation at progressively larger scales: site, enhancement reach, and project reach. This integration, or spatial rollup, allows a robust evaluation of individual project elements across multiple spatial scales.

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[192] Enhancement sites are also evaluated across temporal scales, *i.e.*, the length of time over which certain kinds of responses from management actions can be expected to take place, and the location duration of monitoring to detect that response.

Effectiveness Ratings

Within the AMP, the JMT adopted checklists to evaluate and rate the physical effectiveness of the enhancement projects, derived in part from the quantitative metrics in Table 4-15. The checklists integrate hydraulic (e.g., water depth and velocity) and shelter (e.g., shelter value, percent cover, shelter score) data to evaluate project performance relative to primary metrics, and qualitative observations of features. The ratings of features and habitat units inform ratings of sites, enhancement reaches, and project reaches, which occur at increasingly broader spatial scales. Quantitative data collected to evaluate project performance support qualitative ratings that provide the basis for evaluating the overall effectiveness of habitat enhancement measures. The qualitative ratings describe the relative success of habitat enhancement measures within enhancement sites and enhancement reaches and determine potential future management actions (Table 4-15).

Effectiveness Monitoring Results

Effectiveness monitoring data shows substantial differences in the amount of optimal depth and velocity habitat between constructed off side channel areas (47%) and main channel areas (22%), and between habitat types (**Table 4-16**). The higher percentage of optimal depth and velocity within off side channel areas is consistent across habitat types (alcoves [74%], pools [50%], flatwaters [44%], riffles [8%]) versus the main channel (alcoves [61%], pools [31%], flatwaters [16%], riffles [6%]). Further, offside channel areas show a higher average shelter score for all habitat types (109) than main channel areas (76), which is also consistent across habitat types with the exception of alcoves.

TABLE 4-16
SUMMARY OF PRIMARY PERFORMANCE MEASURES FOR ALL MONITORING TIME PERIODS FROM 2015-2021

Habitat Type and Location (off or main channel)	Percent Optimal Depth and Velocity	Average Shelter Score	Pool to Riffle Ratio
Off channel riffle	8%	66	
Off channel pools	50%	126	
Off channel flatwater	44%	103	
Off channel alcove	74%	157	
Off channel Average	***47%***	***109***	***164: 108 (1.52)***
Main channel riffle	6%	52	
Main channel pools	31%	88	
Main channel flatwater	16%	55	
Main channel alcove	61%	177	
Main channel average	***22%***	***76***	***159:121 (1.31)***

SOURCE: Martini-Lamb, J. and Manning, D.J. editors. 2022. Russian River Biological Opinion Status and Data Report Year 2021. Sonoma County Water Agency, Santa Rosa, CA.

Riffles typically have higher water velocity and shallower depths at low flows than recommended by the AMP (<0.5 f/s velocity; 0.5-4.0 ft depth), and have less complex cover to achieve a shelter score of 80 (as recommended by the AMP). As such, riffles do not support the optimal depth and velocity conditions or shelter score recommended by the *2008 Biological Opinion* or the AMP, but still perform important ecological roles, such as nutrient retention and food production. Although enhanced spawning habitat was not a primary objective, Sonoma Water biologists routinely observe Coho, Chinook, and steelhead spawning in constructed riffles. Observed pool to riffle ratio remained within 1:2 to 2:1 (0.50 to 2.00), as recommended by the AMP, in off and main channel areas.

Enhancement Reach Ratings

As noted above, the qualitative ratings describe the relative success of habitat enhancement measures within enhancement sites and enhancement reaches, and determine potential future outcomes (i.e., management actions). Post-effective-flow-enhancement-reach ratings occur after exposure to at least one geomorphically effective flow and likely reflect restored habitat conditions more accurately than post-enhancement ratings determined just after construction. As such, the ratings that determine management actions are determined by the most recent post-effective flow ratings (**Table 4-17**). After the initial post-effective flow survey, Sonoma Water uses a rotating panel to survey a set of reaches every year (e.g., Reach 8b [Truett Hurst]) and a set of reaches every three years (e.g., Reach 8b [Carlson, Lonestar]).

Validation Monitoring

In addition to the effectiveness monitoring outlined above, the Dry Creek AMP outlines validation monitoring within enhancement reaches. The goal of validation monitoring is to assess whether habitat enhancement is achieving intended biological objectives. Though less important for evaluating overall project success as compared to effectiveness monitoring, validation monitoring can be key in tipping the overall project rating but only in a positive direction. This monitoring can be conducted after project implementation and can occur before, during, or after post-enhancement effectiveness monitoring. Sonoma Water’s *2009-10 Russian River Biological Opinion Status and Data Report* outlined six possible metrics to be considered for validation monitoring of juvenile salmonids with respect to eventual habitat enhancements in mainstem Dry Creek: habitat use, abundance (density), size, survival, growth, and fidelity (**Table 4-18**).[193]

Based on recent validation monitoring, there is clear evidence that juvenile salmonids are utilizing habitat enhancements in Dry Creek (**Table 4-19**). Although habitat utilization by adult salmonids is not a primary metric according to the Dry Creek AMP, presence of adults of all three species in constructed off-channel habitats suggests that benefits are likely accrued to life stages other than juveniles. The deployment of PIT antennas in off-channel habitat provides evidence that constructed habitats support fish in the late-fall and winter. Unfortunately, marginal visibility due to high turbidity and vegetation growth in newly created off-channel habitats often hampers the ability to effectively observe fish during summer/fall snorkel surveys and these features are largely too deep to sample with a backpack electrofisher. The difficulty in sampling specific

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[193] J. Martini-Lamb and Manning, D.J. editors. 2020. Russian River Biological Opinion Status and Data Report Year 2017. Sonoma County Water Agency, Santa Rosa, CA. 401 p.

enhancement features is highlighted by the variability in steelhead densities observed in enhanced versus un-enhanced areas.

TABLE 4-17
POST-EFFECTIVE FLOW EFFECTIVENESS MONITORING BY ENHANCEMENT REACH LISTED FROM UPSTREAM TO DOWNSTREAM

Enhancement Reach	2015	2016	2017	2018	2019	2020	2021	Latest post-effective flow rating
Reach 15 (USACE)	-	Excellent	-	-	Good	-	-	Good
Reach 14b (USACE)	-	-	-	-	Good	-	-	Good
Reach 8a (Gallo)	-	-	-	-	-	Good	Good	Good
Reach 8a (Weinstock)	-	-	-	-	Good	Good	Good	Good
Reach 8b (Truett Hurst)	-	-	Poor	Good	Fair	Good	Good	Good
Reach 8b (Meyer)	-	-	Fair	Fair	-	-	Good	Good
Reach 8b (Carlson, Lonestar)	-	-	-	Good	-	-	Good	Good
Reach 7 (Quivira)	-	Excellent	-	-	-	-	-	Excellent
Reach 7 (Van Alyea)	-	-	Good	-	-	Excellent	-	Excellent
Reach 7 (Rued)	Good	-	-	-	-	-	-	Good
Reach 7 (Farrow Wallace)	-	-	Fair	-	Good	Good	Good	Good
Reach 4a (Ferrari-Carano, Olson)	-	-	-	-	Fair	Fair	-	Fair
Reach 2b (City of Healdsburg Yard)	-	-	-	Good	Poor	-	-	Poor
Reach 2b (Geyser Peak)	-	-	Poor	Fair	Fair	Fair	Fair	Fair

SOURCE: J. Martini-Lamb and Manning, D.J. editors. 2022. Russian River Biological Opinion Status and Data Report Year 2021. Sonoma County Water Agency, Santa Rosa, CA.

TABLE 4-18
PROPOSED TARGET LIFE STAGES, VALIDATION METRICS, SPATIOTEMPORAL SCALE, AND MONITORING TOOLS FOR VALIDATION MONITORING

Spatial Scale	Target Life Stage	Target Metric(s)	Temporal Scale	Primary Monitoring Tools
Site/Feature	Juvenile (non-smolt)	Habitat use, abundance (density), size, growth	Post-construction	Snorkeling, electrofishing, PIT tags and antennas
Reach	Juvenile (non-smolt)	Abundance (density), size, survival, growth, fidelity	Pre-construction (baseline) vs. Post-construction	Electrofishing, PIT tags and antennas
Mainstem Dry Creek	Smolt	Abundance	Ongoing to capture long-term trend	Downstream migrant trap, PIT antennas

SOURCE: J. Martini-Lamb and Manning, D.J. editors. 2020. Russian River Biological Opinion Status and Data Report Year 2017. Sonoma County Water Agency, Santa Rosa, CA. 401 p.

TABLE 4-19
OUTCOMES FROM DRY CREEK ENHANCEMENT VALIDATION MONITORING

Enhancement Reach	Enhancement Type	Juvenile presence (PIT antenna)	Juvenile presence (snorkel or electrofisher)	Adult presence (PIT antenna/snorkel/ spawner survey)
Reach 2b (Healdsburg)	Side channel	Chinook, Coho, steelhead	Coho, steelhead	Chinook, Coho, steelhead
Reach 2b (Geyser Peak)	Side channel	Coho, steelhead	Steelhead	Chinook, Coho, steelhead
Reach 4 (Ferrari-Carano)	Side Channel	Coho, steelhead		Chinook, Coho, steelhead
Reach 7 (Van Alyea)	Backwater, Constructed Riffle (upper and lower)	Coho, steelhead	Steelhead	-
Reach 7 (Rued)	Constructed Riffle	-	Steelhead	-
Reach 7 (Quivira)	Backwater	Coho, steelhead	Steelhead	-
Reach 7 (Farrow)	Backwater	Coho, steelhead	Steelhead	Chinook, steelhead
Reach 7 (Wallace)	Backwater, Constructed Riffle	Coho, steelhead	Steelhead	Chinook, Coho
Reach 8b (Meyer)	Side channel	Coho, steelhead	Chinook, steelhead	Chinook, Coho, steelhead
Reach 8b (Truett Hurst)	Side channel, Alcove	Chinook, Coho, steelhead	Chinook, Coho, steelhead	Chinook, Coho, steelhead
Reach 8b (Carlson)	Side channel	Chinook, Coho, steelhead	Steelhead	Chinook, Coho
Reach 8b (Lonestar)	Side channel, Constructed Riffle	Coho, steelhead	Steelhead	Chinook, Coho, steelhead
Reach 8a (Gallo)	Side channel	Coho, steelhead		Chinook, Coho, steelhead
Reach 8a (Weinstock)	Side channel	Coho, steelhead		Chinook, Coho, steelhead
Reach 14 (USACE)	Side channel	Coho, steelhead	Coho, steelhead	Chinook, Coho, steelhead
Reach 15 (USACE)	Side channel	-	Coho, steelhead	-

SOURCES: https://www.sonomawater.org/reports and unpublished data

Dry Creek Juvenile Population Density

Sonoma Water began sampling for juvenile steelhead in the main channel of Dry Creek beginning in 2008, however sampling locations and methods have varied as construction of habitat enhancements have progressed.[194] From 2015 to 2018, Sonoma Water employed a reach-based approach that relied on the spatially-balanced random sampling framework afforded by the generalized random tessellation stratified (GRTS) framework outlined for CMP implementation.[195] Sampling reaches in this manner over time will result in a broader spatial context thereby facilitating more accurate validation of the effectiveness of habitat enhancement measures in Dry

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[194] Roni, P., editor. 2005. Monitoring stream and watershed restoration. American Fisheries Society, Bethesda, Maryland.

[195] Adams, P.B, et al. 2011. *Op cit.*

Creek. Beginning in 2019, Sonoma Water reduced the number of sampled reaches from nine to three: one section in each of the geomorphically-based reach designations identified by Inter-Fluve.[196] Sampling was conducted with a single pass through the entire stream section on day 1 (the marking event) followed by a second pass two days later (the recapture event). Individuals captured on day 1 were PIT-tagged, released near their capture location and subject to recapture on day 2. From these paired sampling events, the Petersen mark-recapture model in Program MARK was used to estimate end-of-summer abundance.[197] Provided recapture probability, mortality and the proportion of fish leaving the section between the marking and recapture events was the same for the marked group as it was for the unmarked group, the abundance estimates from the paired mark and recapture events in early autumn were unbiased.[198] Density estimates were calculated as the quotient of estimated abundance and wetted area of the site (**Table 4-20**). The length of sampled stream sections varied between 55 and 1,605 meters (average 534 meters).

TABLE 4-20
DENSITY OF JUVENILE STEELHEAD (FISH PER M^2) IN HABITAT ENHANCEMENT SITES FROM 2014-2020

Enhancement Site	2014	2015	2016	2017	2018	2019	2020
Reach 15 SC[1] (USACE)	0.21	0.05	0.02	0.04	0.07	-	-
Reach 14 SC (USACE)	-	-	-	-	-	-	0.28
Reach 8a SC (Weinstock)	-	-	-	-	-	-	0.41
Reach 8b SC (Truett Hurst)	-	-	-	-	0.36	0.68	0.57
Reach 8b CR[2] (Carlson, Lonestar)	-	-	-	0.35	-	-	-
Reach 7 CR (Van Alyea)	-	0.16	-	0.25	-	-	-
Reach 7 CR (Wallace)	-	0.52	-	0.41	-	-	-
Reach 2b SC (City of Healdsburg Yard)	-	-	-	-	0.10	-	-
Reach 2b SC (Geyser Peak)	-	-	-	-	0.37	-	-

NOTES:

[1] Side Channel

[2] Constructed Riffle

SOURCE: Martini Martini-Lamb, J. and Manning, D.J. editors. 2022. Russian River Biological Opinion Status and Data Report Year 2021. Sonoma County Water Agency, Santa Rosa, CA.

Across all subreaches sampled, average juvenile steelhead density in 2019 was 0.32 fish/m^2 (range 0.19 fish/m^2 to 0.51 fish/m^2) (**Figure 4-15**). When averaged for all sites within a year, densities in 2019 were 0.14 fish/m^2 higher than the eleven-year average from 2008-2018. Importantly, the average population density for enhanced sites was greater than for unenhanced sites.

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[196] Inter-Fluve. 2011. Fish Habitat Enhancement Feasibility Study Dry Creek Warm Springs Dam to the Russian River, Sonoma County, CA for Sonoma County Water Agency, Santa Rosa, CA.

[197] White, G. C., and K. P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study 46:120-139.

[198] White, G. C., Anderson, D. R., Burnham, K. P., and Otis, D. L. 1982. Capture-recapture and removal methods for sampling closed populations. Los Alamos National Laboratory, LA-8787-NERP, Los Alamos, New Mexico.

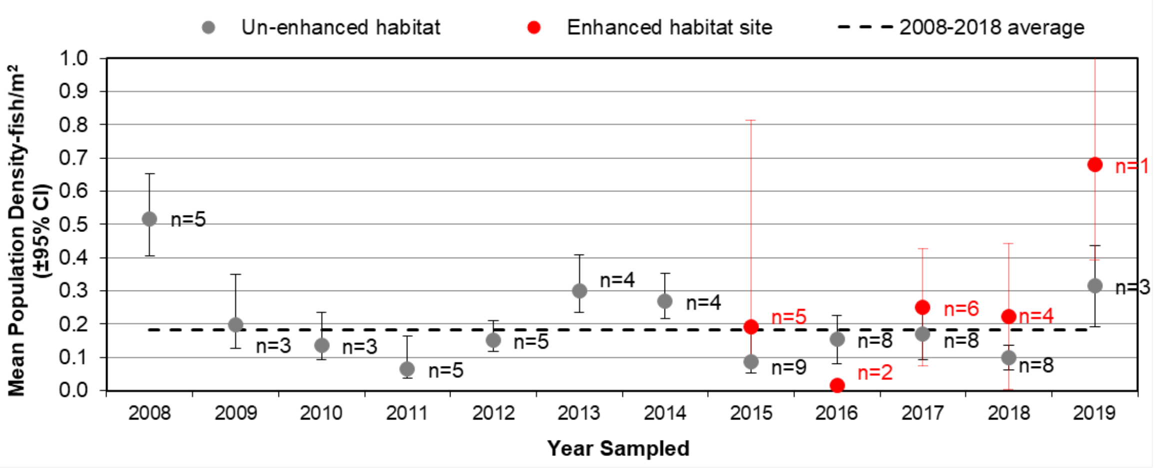

Figure 4-15
Mean juvenile steelhead density among all sites samples within a year in mainstem Dry Creek, 2008-2019. n = number of samples per year

4.5 Water Quality

4.5.1 Temperature

Water temperature has direct and indirect effects on aquatic ecology. For example, oxygen is more soluble in cold water than hot water (i.e., solubility is a function of water temperature); therefore, dissolved oxygen (DO) levels may be higher in waters at lower temperatures. Temperature also influences the rate of photosynthesis by algae and aquatic plants. Water bodies such as the Russian River have naturally fluctuating temperatures due to the dynamic conditions associated with a coastal climate and localized weather patterns. Seasonal changes in water temperature in rivers closely follow seasonal trends in mean monthly air temperature, except that in winter the water temperature does not fall below 0°C (32°F), and air warms more rapidly in the spring than does water. The annual temperature range in temperate rivers is usually between 0 and 25°C (32°F and 77°F).[199] For temperatures above freezing, mean weekly water temperature could be predicted very accurately from air temperatures using a 5 to 7-day lag. Temperatures less than 17°C (62.6°F) are typically preferred by juvenile steelhead. In general, salmonids in warmer waters require more food and oxygen because their metabolism increases with temperature.[200] The high productivity associated with healthy estuaries provides an abundant food source for many fish species and can allow temperature-sensitive fish, such as juvenile salmonids, to withstand greater water temperatures than the typical optimal range, and can result in greater growth rates.[201] The Water

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[199] Allan, J.D. 1995. Stream Ecology: Structure and function of running waters. Reprinted 2006. Dordrecht, The Netherlands: Springer.

[200] Sullivan, K., Martin, D.J., J.E. Cardwell, J.E. Toll, and S. Duke. 2000. An analysis on the effects of temperature on salmonids of the Pacific Northwest with implications for selecting temperature criteria. Sustainable Ecosystem Institute.

[201] Bond, M.H. S.A. Hayes, C.V. Hanson, R.B. MacFarlane. 2008. Marine survival of steelhead (Oncorhynchus mykiss) enhanced by a seasonally closed estuary. Fisheries Ecology Division, NOAA National Marine Fisheries Service, Southwest Fisheries Science Center, 110 Shaffer Road, Santa Cruz, CA 95060, USA. Canadian Journal of Fisheries and Aquatic Sciences, 2008, 65(10): 2242-2252, 10.1139/F08-131.

Quality Control Plan for the North Coast Region (Basin Plan) includes narrative and numeric water quality objectives for temperature that apply to the Russian River.[202]

4.5.1.1 Upper Russian River

Since the completion of CVD and the consequent filling and operation of Lake Mendocino, the Russian River has been transformed into a perennial flowing stream with highly regulated flood flows and dry season base flows. Water temperatures in the Upper Russian River are largely regulated by the temperature of water releases from Lake Mendocino downstream to the Hopland area with seasonal maximum temperatures typically ranging between 10 and 20°C (**Figure 4-16**). A dam that releases surface water will usually increase the annual temperature range immediately downstream, whereas a deep release dam will lessen the annual variation.[203] Lake Mendocino has one release point at the bottom of the lake where the water typically remains colder than surface temperatures until mixing of the stratified water layers occurs in late summer/early fall.

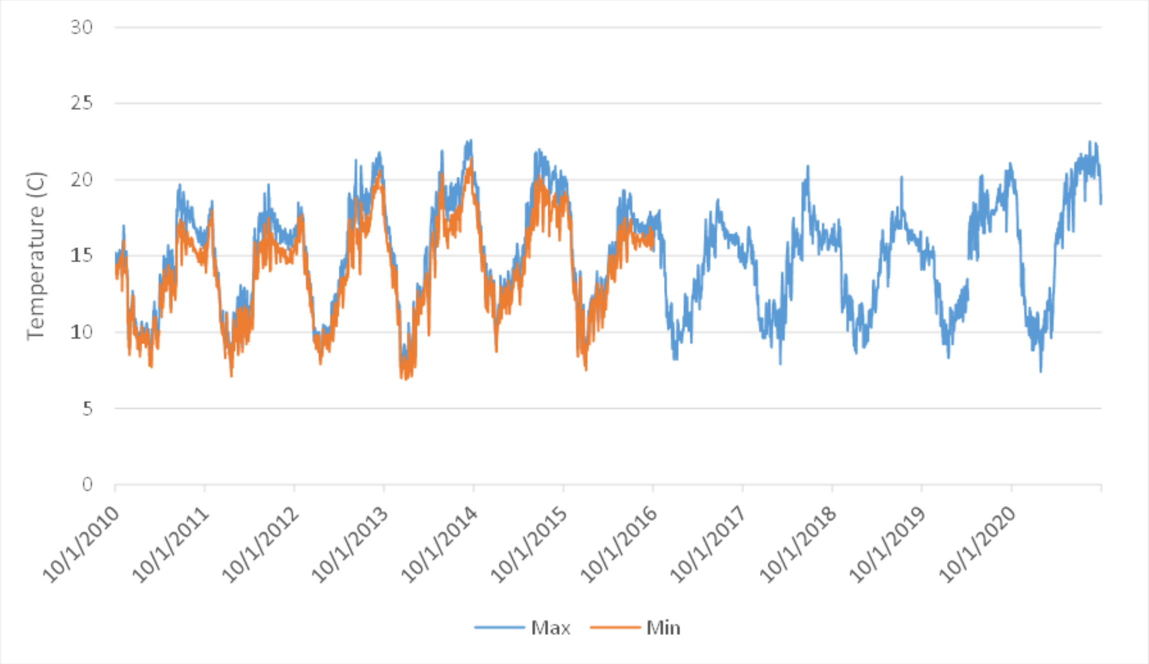

Figure 4-16
Daily Maximum and Minimum Water Temperatures at USGS Hopland stream gage

Lake Mendocino DO concentrations tend to decline at depth in the late spring, often resulting in low DO conditions in the East Fork of the Russian River immediately below the lake. DO levels within the cold-water pool typically remain depressed through the summer months until the lake seasonally mixes. The top 20 to 30 feet of water in Lake Mendocino that is exposed to sunlight (photic zone) remains well oxygenated. However, once the anoxic bottom layer and the

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[202] North Coast Water Quality Control Board (NCRWQCB), 2018. *Op. cit.*

[203] Allan, J.D. 1995. Stream Ecology: Structure and function of running waters. Reprinted 2006. Dordrecht, The Netherlands: Springer.

oxygenated surface layer mix, the DO concentration increases in the bottom layer and decreases in the photic zone to an intermediate concentration.

Atmospheric conditions tend to increase water temperatures during the dry season (May 15 through October 15) as water flows downstream through the Upper Russian River. As a result, dry season daily maximum water temperatures are typically higher in the Healdsburg area (Digger Bend) (**Figure 4-17**) compared to the Hopland area.

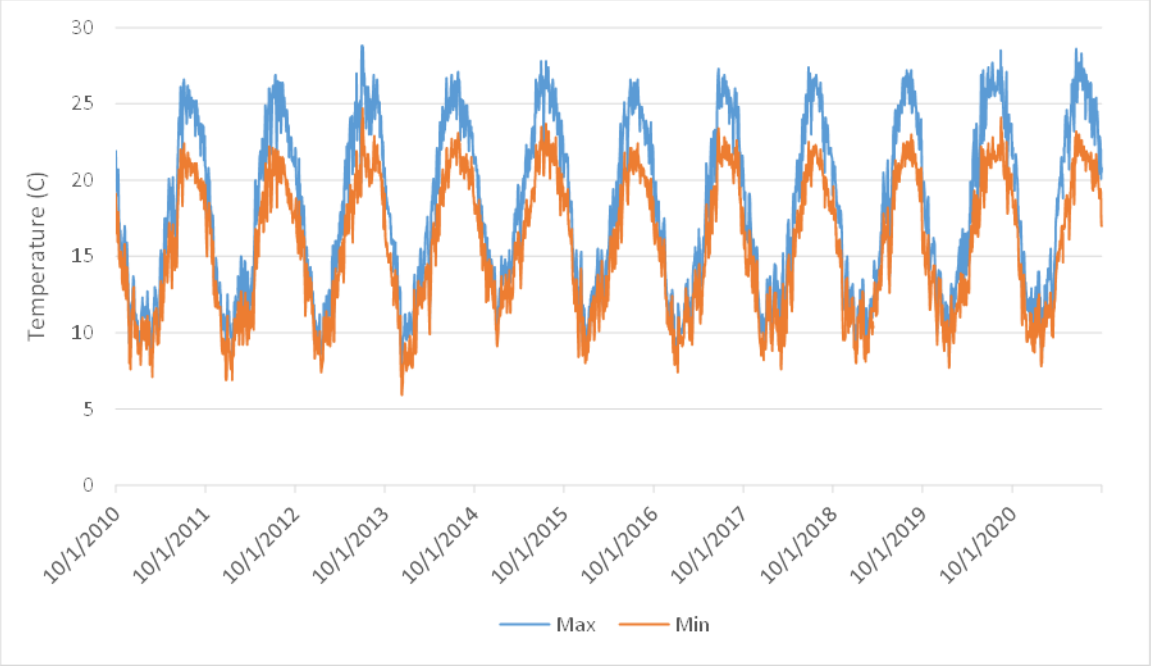

Figure 4-17
Daily Maximum and Minimum Water Temperatures at USGS Digger Bend stream gage

In 2004, Sonoma Water contracted with Watershed Sciences, Inc. to conduct an airborne thermal infrared (TIR) survey of the Russian River and Dry Creek. The overall object of the project was to characterize the thermal regime of the river during July and August.[204] Specifically, the data and analysis produced from this survey were intended to map spatial temperature patterns, document surface water inflows and areas of potential sub-surface upwelling, and identify the availability and extent of thermal refugia for cold-water fish species. Results of this survey from Coyote Valley Dam to Dry Creek are shown below in **Figure 4-18**.

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[204] Watershed Sciences, Inc. 2004. Aerial Survey of the Russian River – Thermal Infrared and Color Videography. February 18, 2005.

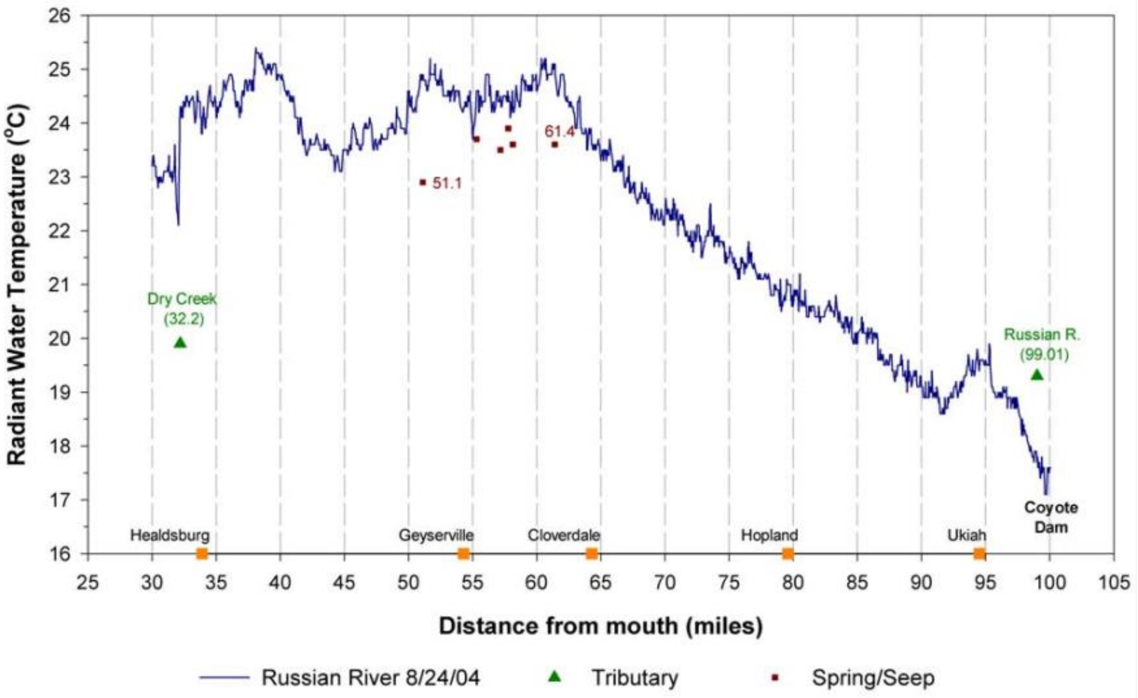

Figure 4-18
Longitudinal Radiant Water Temperature Profile
Upper Russian River – Dry Creek to Coyote Valley Dam

4.5.1.2 Lower Russian River

As with the Upper Russian River, conditions in the lower watershed tend to increase water temperatures during the late-spring and summer months (**Figure 4-19**). However, as the river flows into the Estuary, the natural cooling effect of the air coming off the Pacific Ocean air and tidal migration of cooler ocean water begin to decrease overall water temperatures. Summer longitudinal radiant water temperatures from the Dry Creek confluence to the Pacific Ocean are shown below in **Figure 4-20**. For a description of water quality conditions in the Estuary see Section 4.4.6.7, *Water Quality Monitoring*.

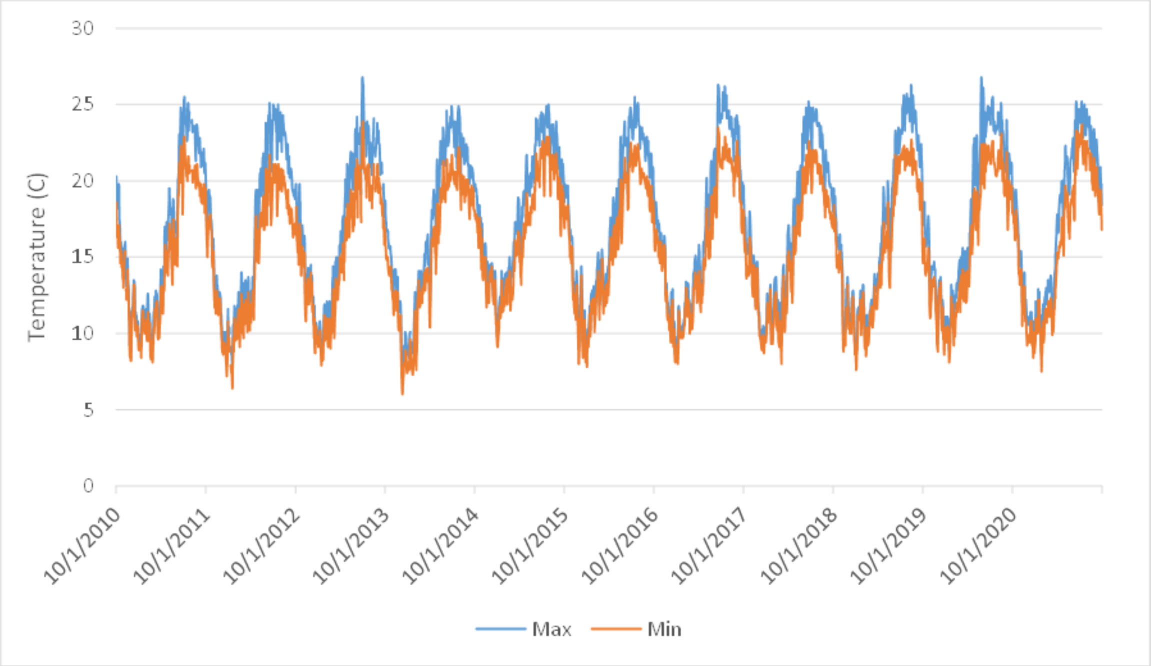

Figure 4-19
Daily Maximum and Minimum Water Temperatures at USGS Guerneville stream gage

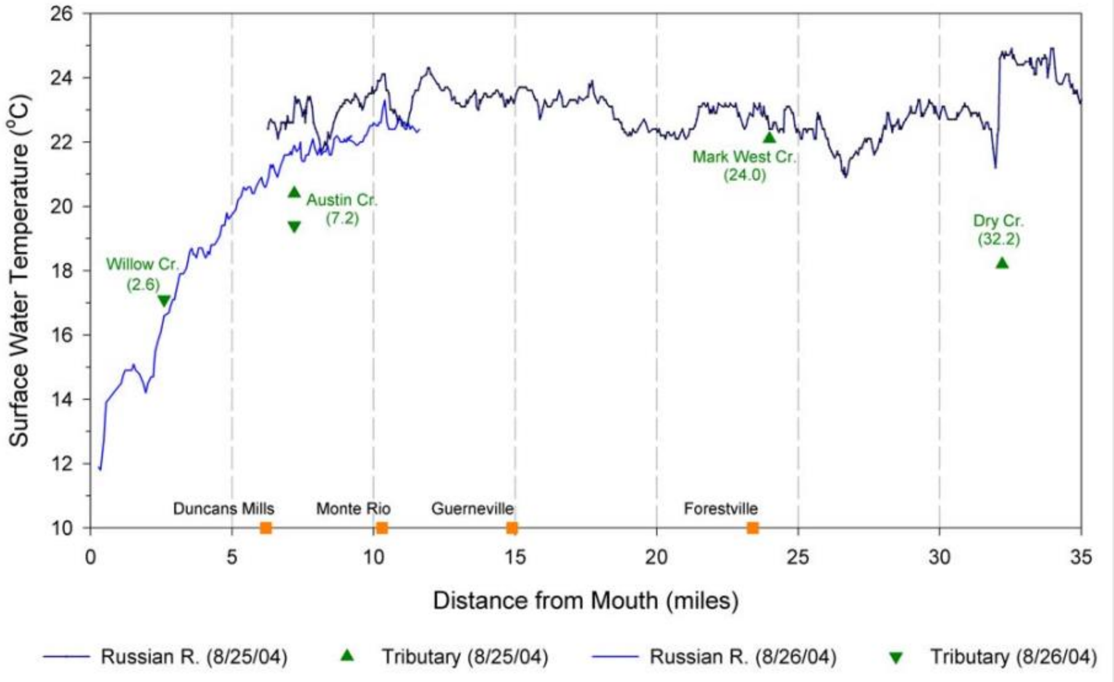

Figure 4-20
Longitudinal Radiant Water Temperature Profile Lower Russian River – Pacific Ocean to Dry Creek

4.5.1.3 Dry Creek

Lake Sonoma is a deep, thermally-stratified reservoir. Because of this, flow releases from Lake Sonoma result in cool water temperatures in Dry Creek that are suitable for rearing juvenile Coho Salmon (**Figure 4-21**). Temperature is regulated by releasing water from the lake through a combination of inlet structures positioned at various depths to provide for water temperatures that are suitable for Warm Springs Hatchery operations. This results in a consistently cool water source flowing down the length of Dry Creek to the confluence with the Russian River. There is also an aeration system to maintain sufficient oxygen levels for use at the hatchery and for release into Dry Creek. Summer longitudinal radiant water temperatures from the Warm Springs Dam to the confluence with the Russian River are shown below in **Figure 4-22**.

Temperature data collected at the USGS Dry Creek below WSD stream gage (USGS 11465240) before and after the construction and operation of Lake Sonoma were observed to have maximum temperatures as high as 27°C before the dam and maximum temperatures in the low 8°C range after the dam.[205] Following construction of WSD water temperatures were driven by releases from Lake Sonoma typically range between 10°C and 17°C (**Figure 4-23**).

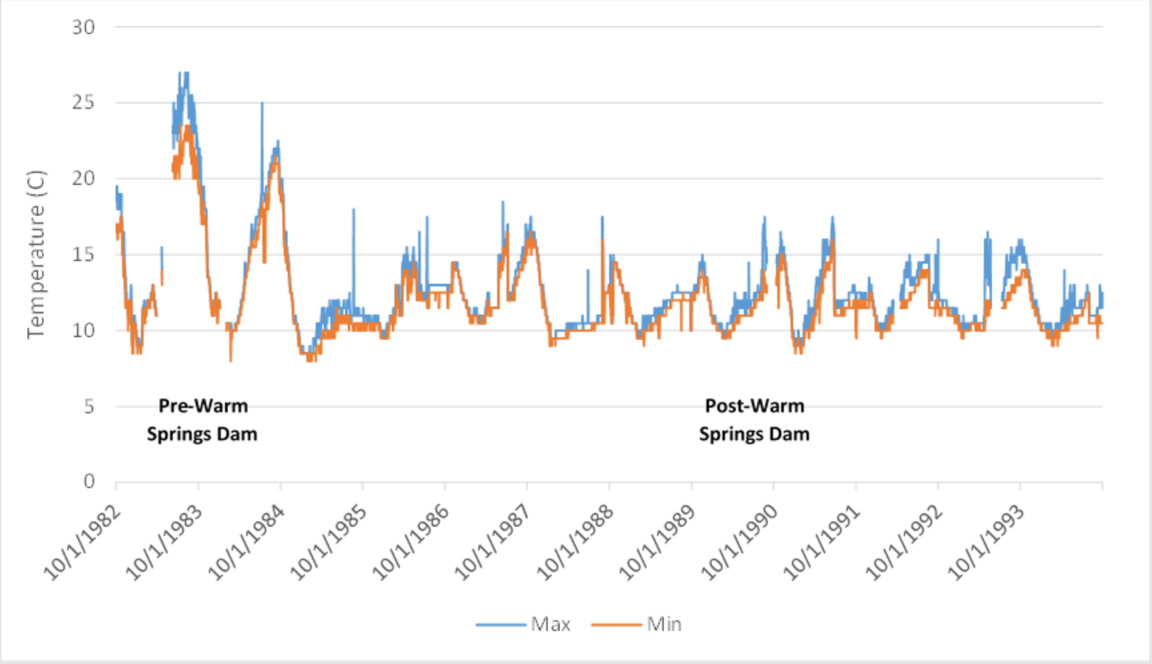

Figure 4-21
Daily Maximum and Minimum Water Temperatures at USGS Warm Springs Dam stream gage

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[205] Water temperature data collected at this gage ceased in September 1994.

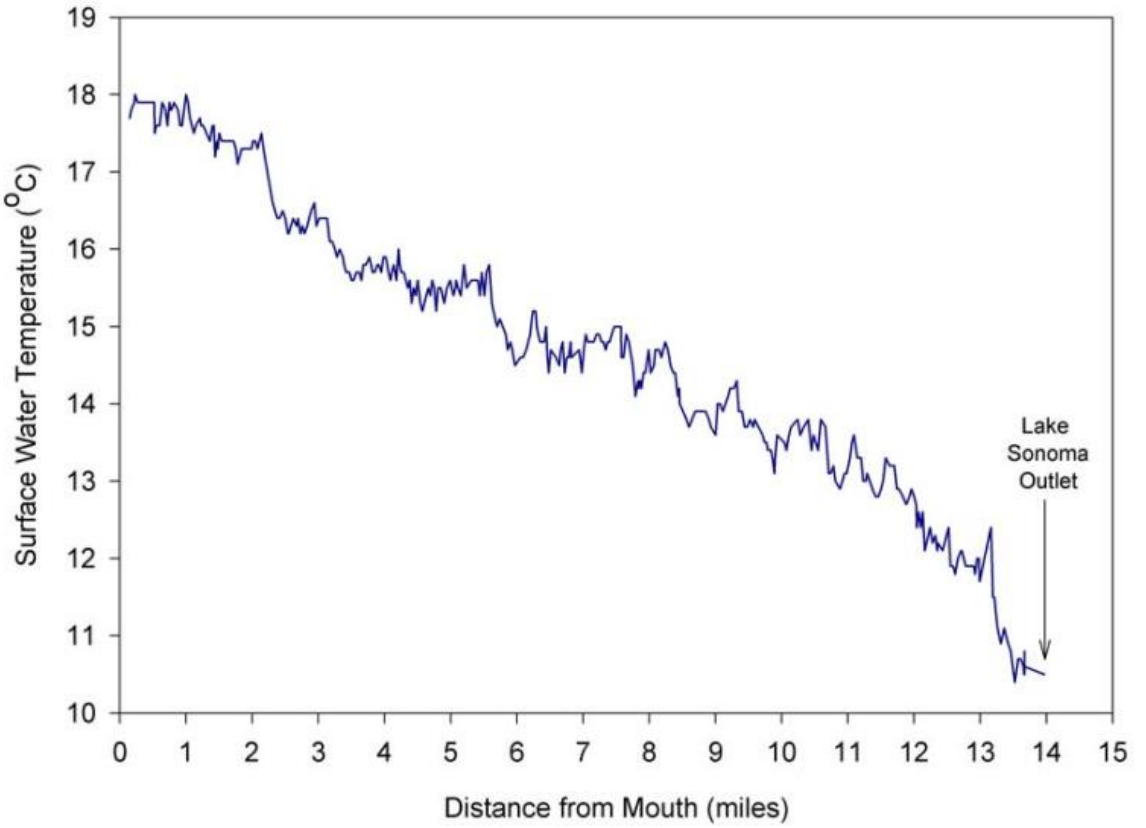

Figure 4-22
Longitudinal Radiant Water Temperature Profile
Russian River confluence to Dry Creek – Warm Springs Dam

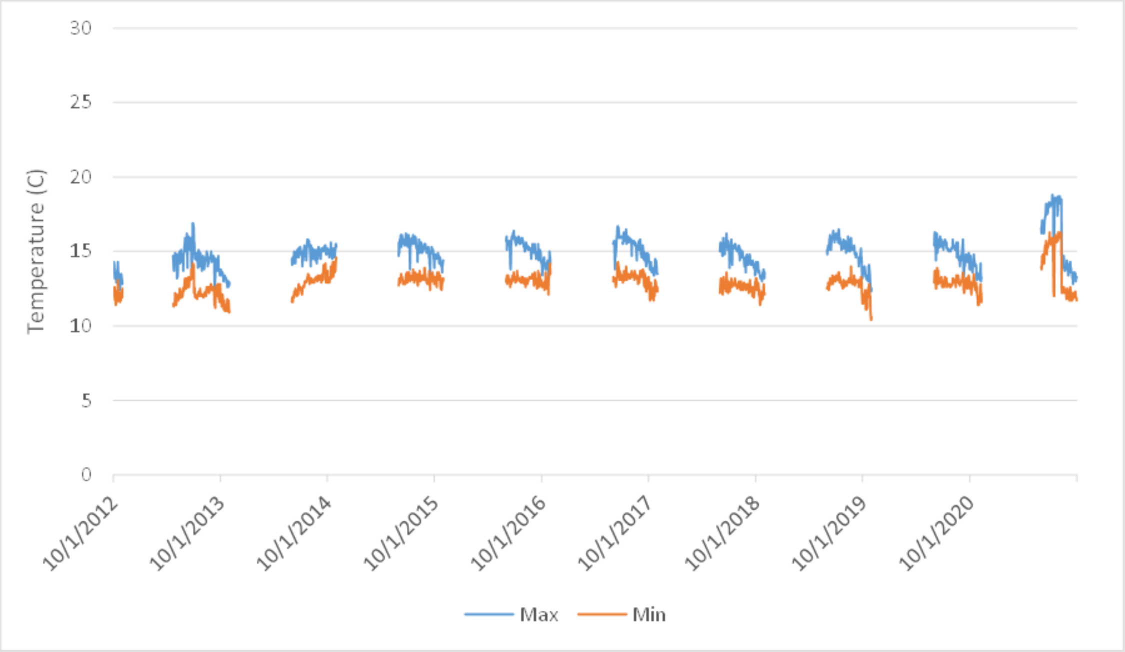

Figure 4-23
Daily Maximum and Minimum Water Temperatures at
USGS Lambert Bridge stream gage

4.5.2 Dissolved Oxygen

DO concentrations also affect habitat quality and use, physiological stress, and mortality of fish and other aquatic organisms. In general, DO concentrations less than 5 to 6 milligrams per liter (mg/l) are marginal to unsuitable for most salmonids.[206] Salmonids generally require a DO level of at least 8 mg/l for optimal growth and survival, and depending on temperature, the lower lethal limit for salmonids is a DO level of around 3 mg/l.

4.5.2.1 Upper Russian River

DO concentrations at Hopland and Digger Bend fluctuate on a daily, seasonal, and yearly basis. DO concentrations tend to be higher during wet season months (November through April) when water temperatures are cooler, and the level of primary production and respiration associated with plant and algal growth decline. The availability of nutrients in the water column can also affect DO concentrations. These nutrients can accumulate in standing water during an extended period of time and contribute to biostimulatory conditions. These conditions can promote excessive plant and algal growth that can alter the concentration of DO through photosynthesis and respiration. Although water temperatures at Hopland are generally cooler than at Digger Bend during the dry season, both stations were observed to have seasonally depressed DO concentrations as well as super-saturation conditions during the recent period of record (**Figure 4-24** and **4-25**).

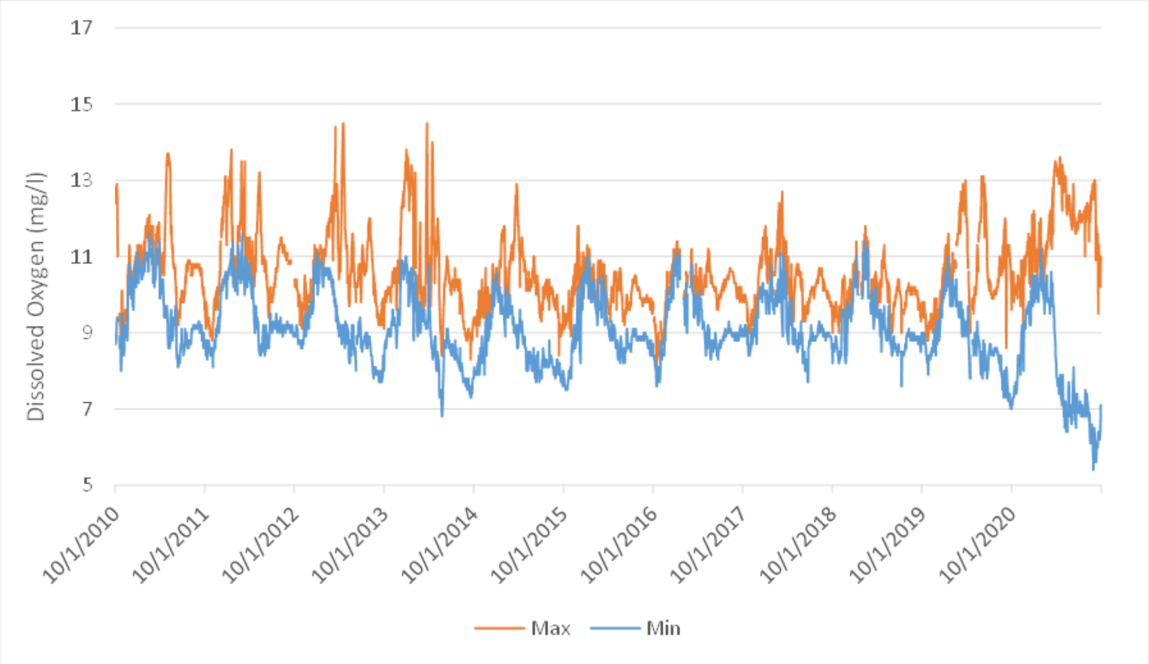

Figure 4-24
Daily Maximum and Minimum Water DO Concentrations at USGS Hopland stream gage

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[206] Bell, M.C. 1973. Fisheries handbook of engineering requirements and biological criteria. U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon, USA. 490 p.

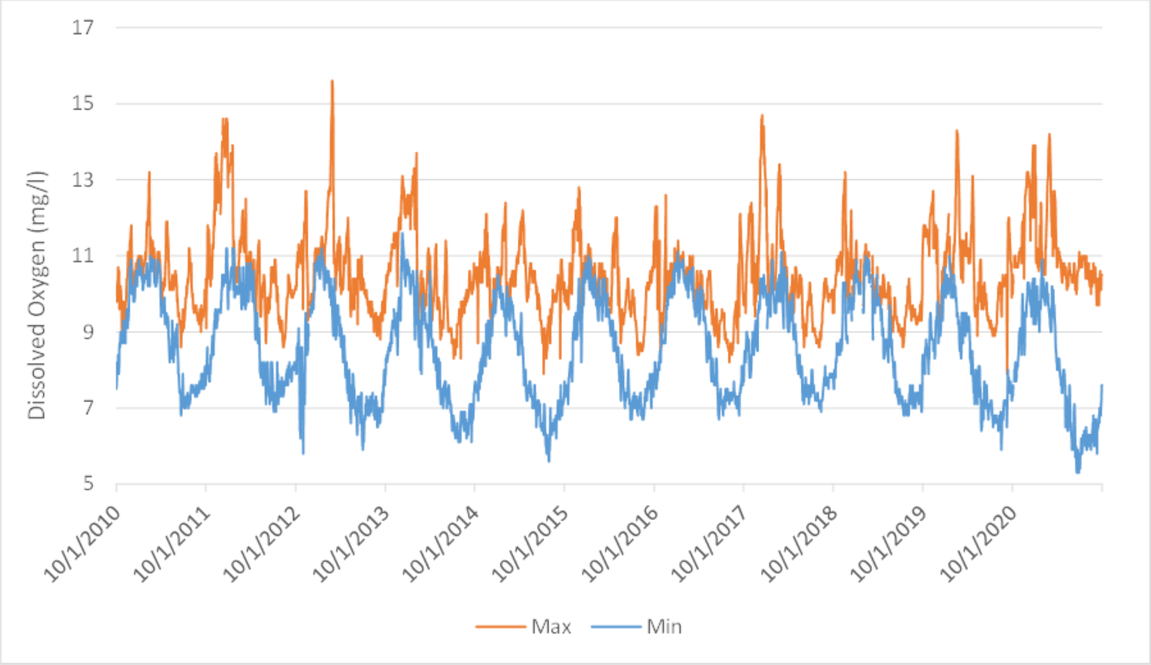

Figure 4-25
Daily Maximum and Minimum Water DO Concentrations at
USGS Digger Bend stream gage

Supersaturated DO concentrations can be caused by excessive plant and algal growth during photosynthesis in which excess oxygen is produced and released into the water column typically during the daytime. Whereas depressed DO concentrations can be the result of excessive plant and algal respiration and decomposition when oxygen in the water column is consumed typically at night.

4.5.2.2 Lower Russian River

As with the Upper Russian River, DO concentrations in the Lower Russian tend to be higher during wet season months (November through April) when water temperatures are cooler. Over the recent period of record, the Guerneville station was observed to occasionally have depressed DO concentrations as well as super-saturation conditions (**Figure 4-26**).

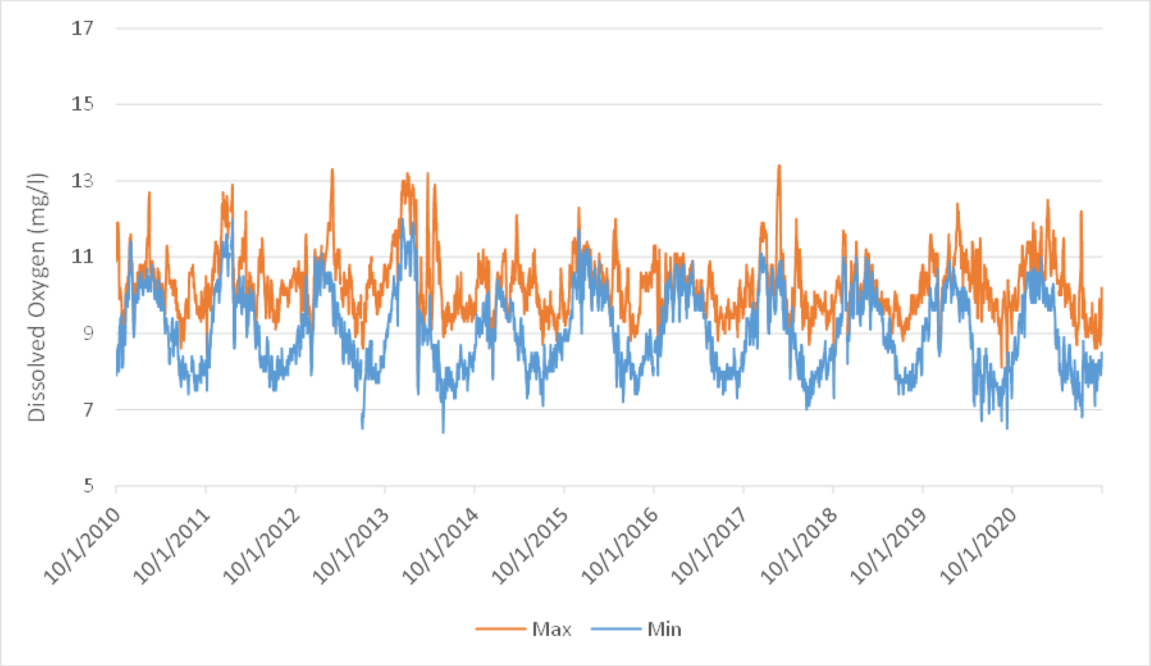

Figure 4-26
Daily Maximum and Minimum Water DO Concentrations at USGS Guerneville stream gage

4.5.2.3 Dry Creek

Current temperatures in Dry Creek compared to pre-dam conditions allow for higher concentrations of DO to be contained within the water column during the warmer, dry-season months. DO data collected at Dry Creek below Lambert Bridge stream gage had concentrations that ranged between approximately 8.8 to 12.2 mg/L from June through October (**Figure 4-27**). DO data is generally recorded every 15 minutes at this stream gage. DO concentrations of at least 7 mg/L are typically considered suitable for rearing salmonids.

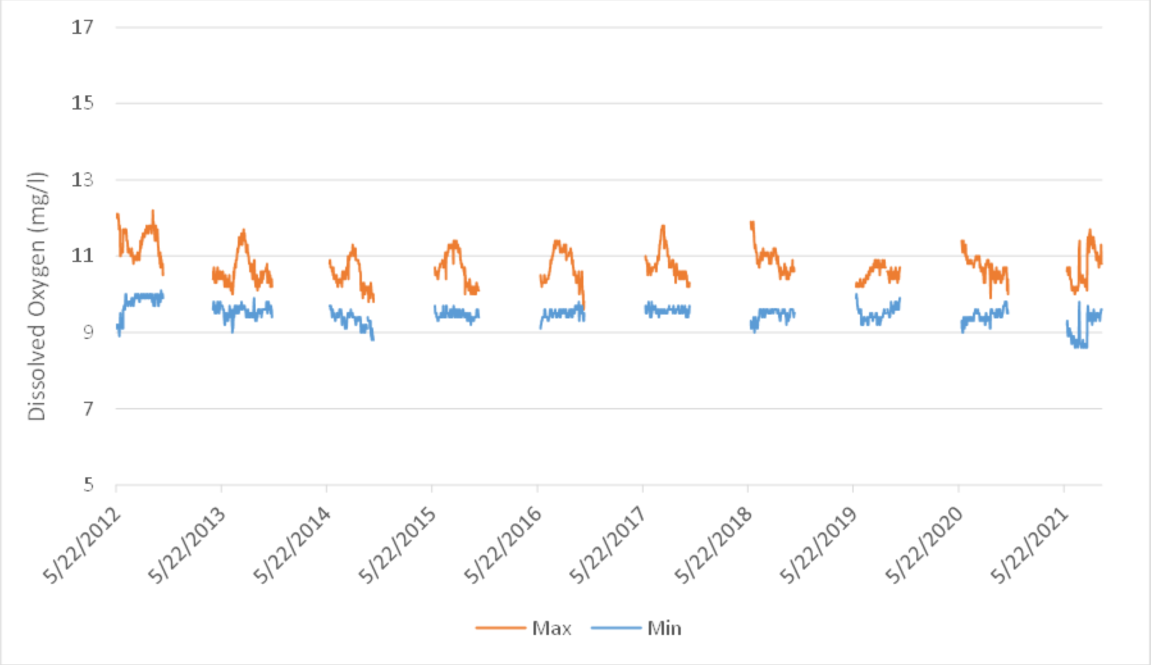

Figure 4-27
Daily Maximum and Minimum Water DO Concentrations at
USGS Lambert Bridge stream gage

4.5.3 Mercury

Lake Mendocino and Lake Sonoma have been listed under Section 303(d) of the Clean Water Act for mercury pollution measured in fish tissue.[207] Mercury is a heavy metal and potent neurotoxin that is harmful to humans and wildlife. Mercury builds up in the bodies of fish and in people who eat contaminated fish. Possible mercury sources include naturally-occurring mercury contained in soils, gold mine spoils, soil erosion due to human activities such as logging and road construction, and airborne sources from North America and Asia. Erosional sources that contribute to mercury accumulation in fish tissue are associated with the active transport of mercury-containing soils into the receiving water body. The degree of mercury accumulation due to erosional sources is dependent in large part on current and past land use practices upstream of the receiving water body coupled with rain and wind transport. Depositional sources are associated with atmospheric mercury that is released into the air as a result of industrial production activities and is also dependent on rainfall and wind transport. The SWRCB is currently developing a statewide mercury program that will include a control program for reservoirs that will address controlling sources of mercury and water quality objectives for mercury. The USEPA recommended water quality criterion for concentrations of methylmercury in fish tissue is 0.3 mg methylmercury/kg fish. This is the concentration in fish tissue that should not be exceeded based on a total fish and shellfish consumption-weighted rate of 0.0175 kg (17.5 grams) fish/day.[208]

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[207] North Coast Regional Water Quality Control Board, 2022. Russian River TMDLs. Webpage accessed May 13, 2022.

[208] USEPA, 2001. Water Quality Criterion for the Protection of Human Health: Methylmercury. Office of Science and Technology. Office of Water. Washington D.C. EPA-823-R-01-001. January 2001.

4.5.4 Monitoring Programs

Water quality monitoring in the Russian River watershed, including Dry Creek, is conducted by the Water Resources Division of the USGS, in cooperation with state and federal agencies; the NCRWQCB; municipalities that discharge into the Russian River and its tributaries; and community groups. In addition, Sonoma Water conducts monitoring as part of several efforts to describe water quality in the Russian River watershed. The USGS maintains several gaging stations in the Russian River and tributaries, including Dry Creek, that measure various constituents including stream flow, stage height, temperature, dissolved oxygen, pH, specific conductance, and turbidity. Several Russian River USGS stations are monitored by Sonoma Water as compliance points for minimum instream flows that are required by Sonoma Water's water right permits and for alternative minimum instream flows authorized through SWRCB-issued temporary urgency change orders. Sonoma Water, Sonoma County DHS, and the NCRWQCB have also collected water samples in order to measure several constituents including nutrients, chlorophyll-a, standard bacterial indicators, algae, and cyanobacteria. The following is a brief description of several water quality monitoring programs that have been and/or are currently being conducted in the Russian River watershed. Water quality monitoring conducted by Sonoma Water within the Russian River Estuary is discussed above.

4.5.4.1 USGS

Beginning in 2003, the USGS, in cooperation with Sonoma Water, collected chemical, microbiological, and isotopic data from surface water and groundwater sites in Mendocino and Sonoma counties.[209] The overall objective of the program was to determine the chemical, isotopic, and microbiological composition of the surface water and ground water in the lower Russian River Basin in the vicinity of the Sonoma Water's water supply facilities where the Russian River water is treated by riverbank filtration and during reduced summer flows. The program included:

1. Data Compilation: A Geographic Information System (GIS) database was compiled to include relevant land use, meteorology, stream daily and storm flow data, historic water quality, and ground water levels for the lower Russian River Basin. The database compiled during this study was incorporated into the GIS database already being developed for the Russian River area by Sonoma Water.
2. Preliminary Evaluation of Water-Quality Data: chemical, isotopic and microbiological data collected from relevant surface-water and groundwater locations to evaluate the overall water-quality conditions within the lower Russian River Basin;
3. Identification of Water-Quality Changes: identify changes in water quality that occur in the vicinity where Russian River water is treated by riverbank filtration; and
4. Assessment of Low-Flow Conditions: the water-quality implications of reduced flows were assessed in the lower Russian River Basin. Field measurements included streamflow, barometric pressure, dissolved oxygen, pH, specific conductance, temperature, and turbidity. All samples were analyzed for nutrients, major ions, trace metals, total and dissolved organic

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[209] Anders, R., Davidek, K., & Stoekel, D.M. 2011. Water quality data for the Russian River Basin, Mendocino and Sonoma Counties, California, 2005-2010: U.S. Geological Survey Data Series 610, 120p.

carbon, organic wastewater compounds, standard bacterial indicators (total coliform, *E. coli*, enterococci, and *Clostridium perfringens*), and the stable isotopes of hydrogen and oxygen.

Between 2003 and 2005 water samples were collected from 10 Russian River sites within the lower Russian River Basin between the city of Healdsburg and the Pacific Ocean, 10 monitoring wells, a gravel-pit terrace site, 11 tributary sites including Mark West Creek, and an Estuary site. All samples were analyzed for nutrients, major ions, trace metals, total and dissolved organic carbon, organic wastewater compounds (OWCs), standard bacterial indicators (total coliform, *Escherichia coli*, and enterococci), the stable isotopes of deuterium and oxygen, and suspended sediment.

In 2006, chemical, microbiological, and isotopic data were collected from 6 main-stem river sites, 8 tributary sites, and a sewage treatment plant along the lower Russian River. In 2007 water samples were collected from 10 surface-water sites along the Russian River three times during the summer and analyzed for the same constituents as previous years. The USGS completed a data report in October 2011 that serves as a compilation of the hydrologic and water-quality data collected from 14 Russian River sites, 8 tributary sites, 1 gravel-terrace pit site, 14 groundwater wells, and a wastewater treatment plant between the City of Ukiah and Duncans Mills for the period August 2005 through October 2010.[210]

4.5.4.2 North Coast Regional Water Quality Control Board Water Quality Data Summary

In 1993, the NCRWQCB summarized Russian River water quality data collected from 1972 to 1992.[211] Water quality parameters in the NCRWQCB report included nutrients, bacteria, physio-chemical, toxic chemicals, and biological parameters. The report found that significant improvements had been made in Russian River water quality since the early 1970s. Significant decreases in the levels of nutrients (nitrates and phosphates) and bacteria in the Russian River and its tributaries were attributed to increased levels of pollution control at municipal, industrial, and agricultural facilities; seasonal prohibitions on discharges to the Russian River during low flow periods; and increased public awareness of water quality issues. The NCRWQCB also summarized water quality conditions in the Russian River for the years 2000 and 2001 and concluded that water quality conditions are generally supportive of NCRWQCB water quality objectives in the Russian River watershed, apart from seasonal temperature impairments in some tributaries and reaches of the Russian River, and seasonal water quality impairments in the Laguna de Santa Rosa.[212]

4.5.4.3 Total Maximum Daily Load Monitoring

Most recently, the NCRWQCB has been collecting water quality monitoring and sampling data to support the Total Maximum Daily Load (TMDL) process. The TMDL process leads to a "pollution

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[210] Anders, R., Davidek, K., & Stoekel, D.M. 2011. Water quality data for the Russian River Basin, Mendocino and Sonoma Counties, California, 2005-2010: U.S. Geological Survey Data Series 610, 120p.

[211] North Coast Regional Water Quality Control Board, 1993. Interim Staff Report Regarding Russian River Water Quality Monitoring. January 27, 1993.

[212] North Coast Regional Water Quality Control Board. 2005. Analysis of Russian River Water Quality Conditions with Respect to Water Quality Objectives for the Period 2000 through 2001. February 2005.

budget" designed to restore the health of a polluted or impaired body of water. The TMDL process provides a quantitative assessment of water quality problems, contributing sources of pollution, and the pollutant load reductions or control actions needed to restore and protect the beneficial uses of an individual waterbody impaired from loading of a particular pollutant. The technical definition of a TMDL is the “sum of the individual wasteload allocations for point sources, load allocations for nonpoint sources and natural background pollutants, and an appropriate margin of safety.” TMDLs serve to identify impaired water bodies, determine the sources of this impairment, and implement mitigation measures to reduce those sources and remove impairments.[213]

Since 2001, the NCRWQCB has been collecting water samples to measure *E. coli* bacteria concentrations at several locations in the Russian River to assess impairment to recreational uses. Most recently, the NCRWQCB has initiated several monitoring and sampling programs and conducted studies on pathogens including a study conducted in coordination with the Aquatic Ecosystems Analysis Laboratory at UC Davis to identify the locations and sources of pathogens in the Russian River and its tributaries.[214]

In August 2019, the NCRWQCB adopted Resolution R1-2019-0038, to amend the Water Quality Control Plan for the North Coast Region (Basin Plan) to include the Russian River Watershed Pathogen TMDL Action Plan (Action Plan). The Action Plan summarized the findings of the TMDL analyses conducted across the Russian River watershed to address pathogen pollution and listings of the Russian River on the Clean Water Act Section 303(d) list of impaired waters (303(d) list). The Action Plan also proposes discrete and identifiable implementation measures that will bring the watershed into compliance with water quality standards and identifies the parties responsible for implementing those measures. The plan sets time schedules by which the responsible parties will implement compliance measures and includes a monitoring plan to track progress towards compliance.[215]

Implementation of the Pathogen TMDL Action Plan in the Russian River Watershed will require close coordination and collaboration of the NCRWQCB with local agencies, including Sonoma Water. To ensure such coordination and collaboration, staff of the NCRWQCB have entered into discussions with each of the counties within the Russian River Watershed, including Sonoma County and Mendocino County. The general purpose of these discussions has been to establish the roles and responsibilities of each of the parties with respect to TMDL implementation. As appropriate, the agreements have been codified in memorandums of understanding (MOU).[216]

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[213] North Coast Regional Water Quality Control Board. 2014. Staff Report for the Integrated Report for the Clean Water Act Section 305(b) Surface Water Quality Assessment and the 303(d) List of Impaired Waters. July 30, 2014.

[214] Viers, J.H., Shilling, F.M., Johnson, M.L., Bowen, L. Hutchinson, R.A., Calanchini, H., Wehrman, A. and H. Schott. 2009. Russian River Pathogen TMDL Monitoring Design: A Summary Report to the North Coast Regional Water Quality Control Board. Project Report 06-428-110 dated September 2009. Aquatic Ecosystems Analysis Laboratory, U.C. Davis.

[215] North Coast Regional Water Quality Control Board. 2019. Action Plan for the Russian River watershed pathogen total maximum daily load (TMDL). August 14.

[216] North Coast Regional Water Quality Control Board. 2016. Memorandum of Understanding (MOU) between the North Coast Regional Water Quality Control Board, the County of Sonoma, and the community development commission relating to the reduction of pathogens in the Russian River watershed and implementation of the Russian River watershed pathogen indicator bacteria TMDL Action Plan. December 13.

4.5.4.4 Surface Water Ambient Monitoring Program (SWAMP)

As part of the NCRWQCB's ongoing Surface Water Ambient Monitoring Program (SWAMP), fish tissue samples were collected as part of a mercury monitoring effort in Lake Sonoma and Lake Mendocino between 2007 and 2009 and were analyzed for methylmercury. Additionally, as part of a regional initiative, the NCRWQCB investigated problems associated with nutrient enrichment (eutrophication) and with increases in algal blooms as a result of bio-stimulatory conditions that had been reported in the South Fork Eel and Russian River watersheds for decades. Results from survey of select areas in the South Fork Eel River in 2010 and in the Russian River in 2011 were summarized in a 2021 report.[217]

The North Coast Region also investigated whether periodic benthic cyanobacterial blooms pose a health risk to the recreating public in the Eel, South Fork Eel, and Russian Rivers. To better understand benthic cyanobacterial growth and cyanotoxin production in these rivers, extensive ongoing monitoring was initiated in 2016 to determine: 1) what cyanobacterial genera are responsible for the formation of toxic benthic mats; 2) what cyanotoxins are being produced; 3) which cyanotoxins are associated with the various mat-forming cyanobacterial genera; and 4) are there spatial and seasonal patterns to mat formation and cyanotoxin production. Results of the study indicated that cyanobacterial growth and cyanotoxin production occurred throughout all sampling sites in the Eel, South Fork Eel, and Russian Rivers, and increased during the summer months until early fall.[218]

While toxigenic benthic cyanobacteria pose a health risk to the recreating public and domestic animals through the incidental ingestion of mat material rather than water, the North Coast Region concluded that additional studies and research are needed to develop benthic criteria to protect the public and animals. The North Coast Region recommended the following future studies:[219]

- Investigate the best approach to standardizing data collection and lab assessment to determine cyanotoxin concentrations in benthic mats for the evaluation of human health, domestic animal, and wildlife protection.
- Determine the cyanotoxin levels in benthic mats that result in threats to public health, domestic animals, and wildlife. This work should include partnering with the Office of Environmental Health Hazard Assessment (OEHHA) to develop thresholds for the ingestion of mat material.
- Develop percent cover thresholds for the benthic mat forming genera of concern: Anabaena, Microcoleus (Phormidium), and Oscillatoria. Benthic trigger levels for public health alerts could be developed that associate percent cover or toxigenic cyanobacterial biomass and

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[217] North Coast Regional Water Quality Control Board, 2021. North Coast Algae and Nutrients Study 2010-2011. South Fork Eel River and Russian River. Surface Water Ambient Monitoring Program (SWAMP). August 2021.

[218] North Coast Regional Water Quality Control Board, 2022. Benthic Cyanobacteria and Cyanotoxin Monitoring in Northern California Rivers, 2016-2019. Freshwater Harmful Algal Bloom Monitoring and Response Program, North Coast Regional Water Quality Control Board, Santa Rosa, CA.

[219] North Coast Regional Water Quality Control Board, 2022. Op. cit.

cyanotoxin concentrations that would pose a threat to the public, domestic animals, and wildlife.

- Focus on the long-term (seasonal) environmental conditions that are supportive of toxigenic cyanobacterial growth and how they are influenced by biostimulatory conditions and other potentially controllable factors.

Analyze the effects of climate change and how altered precipitation patterns or drought influence benthic biomass and cyanotoxin production.

4.5.4.5 Sonoma Water

Temporary Urgency Change Order Monitoring Programs

TUCOs issued by the SWRCB in response to TUCPs filed by Sonoma Water often include water quality monitoring requirements. Water quality data is used to monitor for potential effects to recreation and available aquatic habitat for salmonids (see Section 6.2.4.1, *Water Temperature*). Datasonde data, including temperature and dissolved oxygen measurements, are used to supplement existing data to provide a more complete basis for analyzing spatial and temporal water quality trends due to Biological Opinion-stipulated changes in river flow and estuary management.

The following sections provided a summary of those monitoring efforts.

Datasonde Deployment

In coordination with the USGS, Sonoma Water maintains three, multi-parameter water quality datasondes on the Russian River located at Russian River near Hopland, Russian River at Diggers Bend near Healdsburg, and Russian River near Guerneville (aka Hacienda Bridge). These three datasondes are referred to as “permanent” because Sonoma Water maintains them as part of its early warning detection system for use year-round. The datasondes take real time readings of water temperature, pH, DO, specific conductivity, turbidity, and depth, every 15 minutes.
A fourth datasonde was located at Sonoma Water’s River Diversion System (RDS) facilities near Forestville, but was not deployed in 2014-2016, while replacement of the fish ladder and fish screens at the RDS occurred. In addition to the permanent datasondes, Sonoma Water, in cooperation with the USGS, installed three seasonal datasondes with real-time telemetry at the USGS river gage station at Russian River near Cloverdale (north of Cloverdale at Comminsky Station Road), at the gage station at Russian River at Jimtown (Alexander Valley Road Bridge), and at Johnson’s Beach in Guerneville. The two seasonal datasondes at Cloverdale and Jimtown are included by the USGS on its “Real-time Data for California” website.[220] The data collected by the datasondes are evaluated to determine whether and to what extent reduced minimum instream flows authorized by the TUCOs cause any impacts to water quality or availability of aquatic habitat for salmonids.

In 2009, Sonoma Water staff deployed additional datasondes seasonally in Monte Rio, at Riverfront Park in Windsor, and on the East Fork Russian River that collected hourly readings for

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[220] https://waterdata.usgs.gov/ca/nwis/current?type=all&group_key=county_cd&search_site_no_station_nm=

specific conductance (micromhos), water temperature (degrees Celsius), dissolved oxygen (percent saturation), dissolved oxygen (milligrams per liter), pH (hydrogen ion), depth (meters), and turbidity at the East Fork (nephelometric turbidity units). This effort was also undertaken to evaluate whether and to what extent the reduced flows authorized by the TUCOs cause any impacts to water quality or availability of aquatic habitat for salmonids. Monitoring at Monte Rio continued seasonally through 2019. In July of 2013, Sonoma Water staff permanently deployed a datasonde in the East Fork Russian River to collect hourly data readings for temperature, DO, pH, specific conductance, and turbidity. In 2013, Sonoma Water staff also began to collect vertical profile data in Lake Mendocino for temperature, DO, pH, specific conductance, and turbidity. In 2018, Sonoma Water began deploying a datasonde seasonally in the Russian River below the confluence with Pieta Creek to collect hourly data readings for temperature, DO, pH, specific conductance, and turbidity. Sonoma Water continues to collect data in Lake Mendocino, the East Fork Russian River, and Russian River at Pieta Creek on an annual basis.

Russian River Grab Sampling

The NCRWQCB and Sonoma County DHS have collected grab samples[221] to be analyzed for indicator bacteria as part of the annual freshwater beach monitoring program at several sites on the Russian River. These data have been incorporated in the TUCO annual monitoring reports to further determine the potential changes to water quality and aquatic habitat availability from reduced instream flows.

The USGS water quality effort from 2005 to 2010 discussed above included a large sampling program at eleven surface water sites and four groundwater sites during two sampling events in 2010; the first in June and the second in September. All samples were analyzed for nutrients, major ions, trace metals, total and dissolved organic carbon, a broad suite of organic wastewater compounds (polyaromatic hydrocarbons, disinfection-by-products, selected pesticides and herbicides, and personal care and household products such as fragrances and detergents), by laboratories operated by the USGS. In addition, water samples collected at surface-water sites located at Russian River near Hopland, Russian River at Digger Bend near Healdsburg, Russian River near Guerneville and at Russian River at Casini Ranch were analyzed for human-use pharmaceuticals.

In 2010, the NCRWQCB conducted weekly bacteriological sampling in cooperation with the Sonoma County DHS at upper and lower Russian River beaches that experience the greatest recreational body contact. The NCRWQCB seasonal sampling locations consisted of: Camp Rose Beach, Healdsburg Veterans Memorial Beach, Steelhead Beach, Forestville Access Beach, Johnson's Beach, and Monte Rio Beach. Per request by the SWRCB and to supplement the USGS and NCRWQCB sampling programs, Sonoma Water conducted weekly grab samples from September 21 through October 12 for both pathogens and nutrients at six stations in the Russian River, including Hopland at the USGS gaging station, upstream of Cloverdale at Comminsky Station, Jimtown in Alexander Valley, Digger’s Bend in Healdsburg, Sonoma Water’s River

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[221] Grab samples are samples of water collected from the water column in sample jars and bottles for lab analysis.

Diversion System (RDS) in Forestville, Hacienda Bridge upstream of Guerneville, and Johnson's Beach in Guerneville.

In 2011, Sonoma Water collected grab samples at nine stations in the Russian River including Diggers Bend, Camp Rose, Memorial Beach, below Memorial Beach and above Dry Creek confluence, approximately 1,500 feet below Dry Creek confluence, Riverfront Park, approximately 150 feet below Sonoma Water RDS, approximately 1,300 feet below Mark West Creek confluence, and Steelhead Beach. All samples were analyzed for nutrients, chlorophyll a, standard bacterial indicators (total coliforms, *E. coli*, fecal coliform, and enterococcus), total and dissolved organic carbon, and total dissolved solids.

During the same year, the NCRWQCB collected grab samples for standard bacterial indicators (total coliforms, *E. coli*, and enterococcus) at seven stations in the Russian River, including Alexander Valley Campground, Camp Rose Beach, Healdsburg Veterans Memorial Beach, Steelhead Beach, Forestville Access Beach, Johnson's Beach, and Monte Rio Beach.

In 2012, Sonoma Water collected grab samples at six stations in the Russian River including Hopland at the USGS gaging station, upstream of Cloverdale at Comminsky Station, Jimtown in Alexander Valley, Digger's Bend in Healdsburg, Riverfront Park, and Hacienda Bridge upstream of Guerneville. All samples were analyzed for nutrients, chlorophyll-a, standard bacterial indicators (total coliforms, *E. coli*, and enterococci), total and dissolved organic carbon, total dissolved solids, and turbidity.

Also in 2012, the NCRWQCB seasonal bacteria sampling locations consisted of Cloverdale River Park, Crocker Road (downstream end of Cloverdale River Park below Big Sulphur Creek confluence), Alexander Valley Campground (Jimtown Bridge), Camp Rose Beach, Healdsburg Veterans Memorial Beach, Steelhead Beach, Forestville Access Beach, Johnson's Beach, and Monte Rio Beach.

Several agencies conducted water quality monitoring in the Russian River during the term of the 2013 TUCO. From May 30 through September 4, the NCRWQCB conducted weekly bacteriological sampling for *E. coli* and Enterococcus to support the development of their Pathogen TMDL at eight beaches with recreational activities involving the greatest body contact. Beach sampling locations included Cloverdale River Park, Camp Rose, Healdsburg Veterans Memorial, Steelhead, Forestville Access, Sunset, Johnson's, and Monte Rio. From May 28 through September 3, Sonoma County DHS, in cooperation with the NCRWQCB, also monitored bacterial levels in the water at eight beaches on the Russian River, including seven beaches that the NCRWQCB monitors. Sonoma Water conducted weekly bacteriological, nutrient and algal sampling at six sites along the Russian River from May 16 through October 31 including Hopland, Comminsky Station, Jimtown Bridge, Digger's Bend, Riverfront Park, and Hacienda.

The Sonoma County DHS continued their annual summer beach monitoring for indicator bacteria at nine sites along the Russian River in 2014. Samples were collected at Cloverdale River Park, Camp Rose Beach, Healdsburg Memorial Beach, Steelhead Beach, Forestville Access Beach, Sunset Beach, Johnson's Beach, Monte Rio Beach, and Patterson Point and analyzed for total coliforms and *E. coli*. Data collected for the beach sampling program have been incorporated in the TUCO annual monitoring reports to further determine the potential changes to water quality and aquatic habitat availability from reduced minimum instream flows.

In 2015, Sonoma Water continued to use indicator bacteria grab sampling data collected by Sonoma County DHS for the freshwater beach sampling program. Samples were collected at Cloverdale River Park, Camp Rose Beach, Healdsburg Memorial Beach, Steelhead Beach, Forestville Access Beach, Sunset Beach, Johnson’s Beach, Monte Rio Beach, and Patterson Point and analyzed for total coliforms and *E. coli*. Data collected for the beach sampling program have been incorporated in the TUCO annual monitoring reports to further determine the potential changes to water quality and aquatic habitat availability from reduced minimum instream flows.

From 2016 to 2021 Sonoma Water, continued DHS bacterial monitoring at the above-mentioned sites, as well as Sonoma Water conducting algal and cyanobacterial monitoring for the annual TUCOs that includes grab sampling for nutrients, chlorophyll-a, total and dissolved organic carbon, total dissolved solids, and turbidity. Sonoma Water sites have changed slightly over the years; specific site information is available in the annual TUCO reports.

Operations Monitoring Program

Sonoma Water conducts an ongoing program to sample (approximately monthly) for coliform bacteria at the RDS facility. Special sampling from seven sites on the Russian River (Camp Rose, Memorial Beach, Steelhead Beach, Sunset Beach, Johnson's Beach, Vacation Beach, and Monte Rio) was also conducted during the two Temporary Urgency Order years (2004 and 2007) and included bacterial indicators, temperature, DO and pH.

Estuary Grab Sampling Programs

Nutrient and indicator bacteria (pathogen) sampling was undertaken in the Russian River Estuary in 2009 to satisfy requirements identified in the Sonoma Water’s 2009 TUCO to reduce minimum instream flows in the Russian River, which was done to satisfy requirements of the *2008 Biological Opinion*. Sampling was conducted at three stations in 2009 including at the Jenner Boat Ramp, Bridgehaven, and Duncans Mills at the Moscow Road Bridge. Sampling stations were added from 2010 through 2013 to include Casini Ranch and Monte Rio for a total of five sample collection stations. From 2014 through 2016, two sampling locations were shifted from Bridgehaven and Duncans Mills to Patterson Point and Vacation Beach to extend monitoring to additional public recreational areas. The Bridgehaven station is primarily an unimproved kayak and canoe launch point in a predominantly estuarine environment and the Duncans Mills station is located on private property not accessible to the general public. Whereas the Patterson Point station is located at a privately owned, but publicly accessible beach in Villa Grande, and the Vacation Beach station is located near Guerneville at a public beach with a summer road crossing and summer dam that allows for launching boats. Sampling generally continued to be conducted between May 15 and October 15 at Patterson Point, Monte Rio, and Vacation Beach from 2017 through 2022. However, sampling was discontinued at the Jenner Boat Ramp and Casini Ranch after the 2016 season. The Jenner Boat Ramp is located in a predominantly estuarine habitat and Casini Ranch is a private campground.

4.6 Water Operations Facilities

Sonoma Water is the local sponsor for the two federal water supply and flood control reservoirs in the Russian River watershed. Coyote Valley Dam (CVD) at Lake Mendocino is located on the East Fork Russian River near the City of Ukiah in Mendocino County. Warm Springs Dam (WSD) at Lake Sonoma on Dry Creek is located near the City of Healdsburg in Sonoma County. Sonoma Water, as local sponsor, partially financed the construction of Coyote Valley and Warm Springs dams under agreements with USACE. Sonoma Water manages water supply storage within Lake Mendocino and Lake Sonoma to optimize the water supply yields of the reservoirs, and controls releases from the water supply pools of both reservoirs to maintain the minimum instream flow requirements specified in its water right permits and for downstream authorized uses along the upper Russian River, lower Russian River, and Dry Creek, including diversions for domestic, municipal, industrial and agricultural purposes. Pacific Gas and Electric Company's (PG&E) Potter Valley Hydroelectric Project (PVP), which includes Lake Pillsbury, diverts water from the Eel River watershed into the Russian River watershed, and some of this water flows into Lake Mendocino. The USACE manages flood control operations at Lake Mendocino and Lake Sonoma.

Sonoma Water makes water supply releases from Lake Mendocino and Lake Sonoma as necessary to comply with its water right permits, which implement the provisions of the State Water Resources Control Board's (SWRCB) Decision 1610. Sonoma Water's permits authorize diversions to storage in Lake Mendocino and Lake Sonoma, and re-diversions of water released from storage and direct diversions at points downstream. Collection of water into storage in Lake Mendocino's water supply pool is authorized by the Sonoma Water's water right Permit 12947A and collection of water into storage in Lake Sonoma's water supply pool is authorized by the water right Permit 16596. Additionally, these permits and permits 12949 and 12950 authorize Sonoma Water to directly divert water from the Russian River. These permits specify an overall limit on total direct diversions and re-diversions of 75,000 acre-feet per year (AFY). Additional information regarding Sonoma Water's water right permits and water supply agreements is provided in Section 4.7.3, *Water Right Permits*.

During times of sufficient rainfall, when natural flows provide enough water to meet minimum instream flow requirements at downstream USGS gages (compliance points), Sonoma Water limits releases from the water supply pools in Lake Mendocino and Lake Sonoma to the amounts needed to meet minimum instream flow requirements as described in the SWRCB's Decision 1610. For Lake Mendocino, there is a 25 cubic feet per second (cfs) minimum instream flow requirement in the East Fork Russian River immediately downstream of the dam to the confluence with the West Fork Russian River. For Lake Sonoma, minimum releases are made to augment unimpaired flows to meet minimum instream flow requirements in Dry Creek, which also meet Don Clausen fish hatchery flow requirements. During periods of insufficient unimpaired flow, Sonoma Water must make releases of water from storage to ensure that the required minimum instream flows are maintained at compliance points along the Russian River and Dry Creek. In the spring and early summer, when there is typically contributing tributary flow, Sonoma Water makes reservoir releases to meet minimum instream flow requirements at the closest compliance point downstream of each reservoir. For Coyote Valley Dam, the closest downstream compliance point is the confluence of the East Fork and the West Fork Russian River (the Forks), and for Warm Springs Dam this point is the USGS Dry Creek near Geyserville gage (Dry Creek Geyserville gage). As natural flows recede during the dry season, the minimum instream flow compliance points transition from upstream flow gages to gages further downstream. For Lake Mendocino the farthest downstream compliance point is the Healdsburg gage in the upper Russian River, and, for Lake Sonoma, the farthest downstream compliance point is the USGS Russian River at Guerneville gage (Hacienda gage) in the lower Russian River. Sonoma Water receives little information from other entities, such as other public water systems or agricultural diverters, to help determine the amounts of releases from Lake Mendocino and Sonoma to meet minimum instream flow requirements. Instead, Sonoma Water normally sets releases by frequently considering data from USGS gaging stations on the Russian River and Dry Creek, and by using Sonoma Water's understanding of how reach losses change both with forecasted weather conditions and seasonally, and estimated travel times for releases to be observed at the compliance point. Sonoma Water does not divert any water from the Russian River between Lake Mendocino and the Russian River's confluence with Dry Creek, but Sonoma Water does have an agreement that authorizes diversions by the City of Healdsburg from this reach under the Sonoma Water's water right permits. Sonoma Water diverts water from the Russian River at its Wohler and Mirabel diversion facilities near Forestville and conveys that water through its water transmission system to its customers.

4.6.1 Lake Mendocino and Coyote Valley Dam

Lake Mendocino is located approximately six km northeast of the City of Ukiah on the East Fork Russian River in Mendocino County, California, and was created by Coyote Valley Dam. The watershed contributing to Lake Mendocino encompasses an area of 272 km^2 , which is approximately seven percent of the Russian River watershed. The average water year inflow into Lake Mendocino is approximately 235,000 acre-feet per year, with a peak water year inflow of 443,000 acre-feet in 1983 and a minimum water year inflow of 60,000 acre-feet in 1977. Inflow into the reservoir consists of unimpaired flows from the contributing watershed and water imported from the Eel River by the PVP. Unimpaired stream flows create most of the Russian River flows downstream of Coyote Valley Dam to the Russian River's confluence with Dry Creek during the rainy season (November through April). During the drier months of May through October, water released from Lake Mendocino storage provides most of the flows in the Russian River upstream of Dry Creek.

4.6.1.1 Flood Control Operations

The USACE oversees flood control operations at both CVD at Lake Mendocino and WSD at Lake Sonoma. Flood control operations are managed in accordance with procedures specified in the Water Control Manual (WCM). The WCM for CVD and Lake Mendocino was originally developed in 1958. The most recent revision of the manual was released in August 1986, with periodic additions and updates: in 1993 (WCM Exhibit D. *Drought Contingency Plan*); 2003 (WCM Exhibit A. *Standing Instructions to Damtenders*); and 2011 (WCM Exhibit E. *Operational Requirements for Pre-Flood and Periodic Inspections and Maintenance Activities*). USACE also conducts annual pre-flood release inspections and periodic five-year inspections of the release facilities at CVD. The rate at which water is released from each reservoir during inspections is specified by the operational guidelines for flood releases, annual pre-flood inspections, and periodic five-year inspections.

The *2008 Biological Opinion* concluded that CVD and WSD operations, including flood management, annual pre-flood, and five-year periodic inspections reduced flood peaks that historically both formed and maintained aquatic and riparian habitat, increased the duration of flows that induce to streambed scour and bank erosion, and increased turbidity levels downstream of the dams, all which could have an adverse effect on incubating and rearing Chinook Salmon and steelhead. Additionally, the *2008 Biological Opinion* determined that high down ramping rates of flow releases during flood control operations may cause dewatering or the disconnection of off channel areas in portions of channels downstream of each dam, resulting in the potential to strand rearing juvenile salmonids. In response, the *2008 Biological Opinion* included RPMs designed to address streambed scour and bank erosion, down ramping rates, and turbidity to minimize reservoir flood operation impacts on salmonids below CVD.

RPM-2 and RPM-3 and their current status are summarized briefly below:

- **RPM-2**: Undertake measures to ensure that harm and mortality to listed salmonids from pre-flood/periodic maintenance at CVD are low.

RPM-2 focused on minimizing and avoiding stranding of juvenile steelhead during annual pre-flood and five-year periodic inspections at CVD. It was determined that stranding may occur since inspections require USACE to halt flow for a period of two hours. The cessation of flow into the East Fork Russian River has the potential to strand juvenile steelhead in both the East Fork and mainstem Russian River. As of the issuance of the *2008 Biological Opinion*, there was no bypass capable of providing flow to the East Fork Russian River during inspections or repairs at CVD. Thus, the objective of RPM-2 was to install a flow bypass system at CVD to minimize and avoid harm or mortality to juvenile steelhead during all inspections and repairs at the dam.

To address RPM-2, USACE made a series of revisions to the WCM for CVD, delineated in WCM Exhibit E, date June 2011. Specifically, Operational Requirements for Pre-Flood and Periodic Inspections and Maintenance Activities (WCM Exhibit E) were developed. Within Exhibit E, USACE evaluated the use of a manned motorized outlet tunnel inspection vehicle (MOTIV) to inspect the outlet tunnel thereby allowing flow to be maintained during the inspection period. However, use of the MOTIV has since been discontinued due personnel safety concerns. WCM Exhibit E also contains a Supplemental Operation Schedule for Routine Inspection and Maintenance Activities, which includes an updated ramping schedule (**Table 4-21**) and communication protocol between USACE and NMFS prior to, during, and subsequent to the inspection. The updated ramping schedule was designed to addresses concerns during the low flow period when inspections occur. Lastly, WCM Exhibit E outlines procedures for monitoring juvenile fish status in the East Fork and mainstem Russian River during inspections.

TABLE 4-21
TYPICAL COYOTE VALLEY DAM WATER CONTROL MANUAL EXHIBIT E, DATE JUNE 2011, RAMPING SCHEDULE MAINTENANCE ACTIVITIES DURING INSPECTIONS OF CVD.

Time	Flow Release (cfs) from Coyote Valley Dam	Action	Flow Release (cfs) to East Branch Russian River from Coyote Valley Dam
0600	125	Start ramp down.	125
0700	100	Ramp down.	100
0800	75	Ramp down.	75
0900	50	Ramp down.	50
1000	0	Inspection period.	5-10 from stilling basin
1100	0	Inspection period.	5 from stilling basin
1200	100	Start ramp up.	100
1300	125	Normal operating flow.	Approximately 125-250

SOURCE: Supplemental Operation Schedule for Routine Inspection and Maintenance Activities, from WCM Exhibit E (date June, 2011). Operational Requirements for Pre-Flood and Periodic Inspections and Maintenance Activities.

Subsequently, in a letter to the SWRCB in response to Sonoma Water's 2017 TUCP, NMFS indicated that the revised ramping rates for the non-flood water supply releases were still subject to take authorization. Furthermore, NMFS indicated that ramping rates during the non-flood water supply period were of special concern for adult, kelt, and smolt intra-watershed movement, and may still contribute to fry and juvenile stranding. NMFS indicated that in lieu of take authorization the SWRCB should set ramping rates at a maximum of 12 cfs/hr and no more than 24 cfs/day.[222] Successive TUCPs have also specified these ramping rates (see *Temporary Urgency Change Petitions*).

- **RPM-3**: Undertake measures to ensure that harm or mortality to listed salmonids from ramping procedures at CVD are low.

With respect to ramping rates in the Russian River downstream of CVD, the *2008 Biological Opinion* summarized the basis for RPM-3, as follows:

> *"… ramp down of flood releases can strand juvenile salmonids on gravel bar surfaces or off-channel habitats by reducing river stage elevation too quickly for juvenile salmonids to follow the receding river elevation. Juvenile salmonids that are stranded in off-channel habitat or in cobble substrates are subject to increased mortality. Stranding of juvenile salmonids is expected to be most problematic in the mainstem Russian River below the East Fork Russian River downstream approximately four miles. This reach is particularly susceptible to stranding due to the presence of alternate gravel bars and off-channel high flow habitats that are utilized by juvenile salmonids."* (p. 320)

It was further specified that USACE determine if ramping procedures at CVD could be modified to minimize and avoid adverse impacts to listed salmonids, and if possible, to make modifications to ramping procedures to prevent such impact.

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[222] NMFS, 2017. Email from B. Coey at NMFS. Ramping Rate Criteria and Analysis.

To address additional requirements specific to RPM-3, USACE and NMFS monitored fish stranding and stage height changes along eight transects in the upper Russian River between the forks and the Perkins Street Bridge under a series of flow releases.[223] Results from the monitoring effort suggested that higher ramp down rates (i.e., 500 cfs/hour to 1000 cfs/hour) were likely to have adverse impacts to listed salmonids.

4.6.1.2 Water Supply Operations

Sonoma Water has responsibility for water supply releases when the reservoirs are in their water conservation pool.[224] Consistent with their role as local sponsor, during this period Sonoma Water manages water supply releases from both reservoirs in accordance with its water right permits issued by the State Water Resources Control Board (SWRCB) (see below). Lake Mendocino's total current storage capacity is 116,500 acre-feet, with a water supply pool between 68,400 acre-feet (November to March) and 111,000 acre-feet (May to October). Lake Mendocino's Pool Schedules is shown below in **Figure 4-28**. Releases from Lake Mendocino at CVD primarily support demands and maintain instream flows in the upper reaches of the Russian River down to its confluence with Dry Creek.

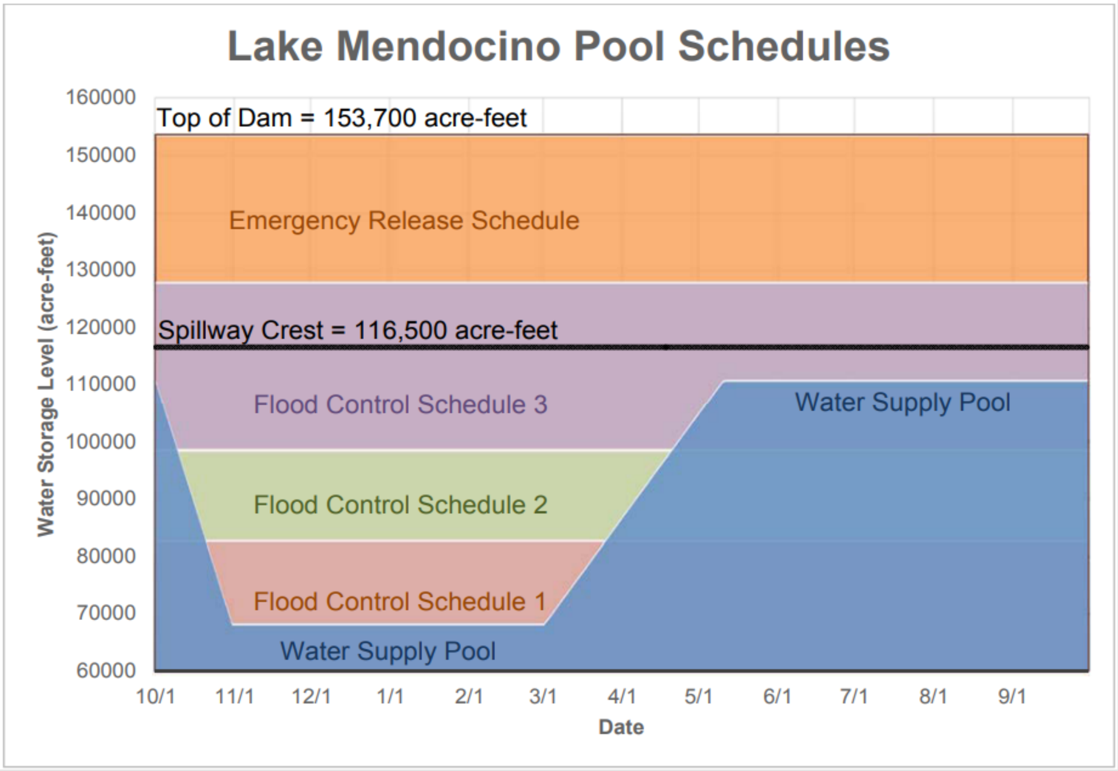

Figure 4-28
Lake Mendocino Flood Control and Water Supply Pool Schedules

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[223] NMFS, 2011. A Proposed Plan for Minimizing the Effects of Flow Release ramp-downs at Coyote Valley Dam on Threatened Salmon and Steelhead in the Russian River.

[224] Sometimes referred to as the "water supply pool."

The *2008 Biological Opinion* determined that the assumptions governing the minimum instream flow requirements as established in Decision 1610 were no longer appropriate. Decision 1610 assumed that higher instream flows were better for fisheries resources, however, subsequent studies within the Russian River and Dry Creek indicated that higher flows were not always beneficial to salmonids. The 2008 Biological Opinion concluded that:

> *"…continued operations of Coyote Valley Dam and Warm Springs Dam by the USACE and Sonoma Water in a manner similar to recent historic practices were likely to jeopardize and adversely modify the critical habitats of endangered Central California Coast Coho Salmon and threatened Central California Coast steelhead."* (p. xvi)

Specifically, NMFS determined that artificially elevated summertime minimum flows resulted in high water velocities. These elevated velocities led to reductions in the quality and quantity of rearing habitat for Coho Salmon and steelhead. Additionally, NMFS concluded that maintaining these flows disrupts lagoon formation in the Russian River Estuary and therefore impairs juvenile salmonid rearing habitat. To address these concerns, the *2008 Biological Opinion* provided an RPA that included options to pursue changes to Decision 1610 to reduce minimum flows in the Russian River and Dry Creek between late spring and early fall via Sonoma Water filing Temporary Urgency Change Petitions (TUCPs) with the SWRCB.

The *2008 Biological Opinion* indicated that the following flow schedule may achieve the intended flow reduction objectives:

During Normal Years:

- Reduce the minimum flow requirement between the mouth of Dry Creek and the mouth of the Russian River from 125 cfs to 70 cfs.
- Reduce the minimum flow requirement in the Russian River from the East Fork to Dry Creek from 185 cfs to 125 cfs between June 1 and August 31; and from 150 cfs to 125 cfs between September 1 and October 31.
- Reduce the minimum flow requirement in Dry Creek from Warm Springs Dam to the Russian River from 80 cfs to 40 cfs from May 1 to October 31.

During Dry Years:

- Reduce the minimum flow requirement between the mouth of Dry Creek and the mouth of the Russian River from 85 cfs to 70 cfs.

In addition, the *2008 Biological Opinion* indicated that in pursuing California Environmental Quality Act (CEQA)/NEPA compliance, Sonoma Water may develop an alternative minimum flow schedule that meets the goals of restoring functional salmonid rearing habitat in Dry Creek, the upper mainstem, and the Estuary, and thereby increase population abundance and growth rates, while promoting water conservation and limiting adverse effects on other instream resources.

As an interim measure for restoration of freshwater habitats for listed salmon and steelhead until permanent changed to Decision 1610 are in place, the *2008 Biological Opinion's* RPA included

Sonoma Water filing TUCPs with the SWRCB to request that minimum bypass flows of 70 cfs be implemented at the USGS gage at Hacienda Bridge between May 1 and October 15, and that Sonoma Water request a minimum bypass flow of 125 cfs at the Healdsburg gage between May 1 and October 15 for purposes of enhancing steelhead rearing habitats downstream of CVD to and Hopland.

Temporary Urgency Change Petitions

Sonoma Water has annually filed TUCPs with the SWRCB in order to implement the *2008 Biological Opinion's* RPA and in response to prevailing Lake Mendocino storage conditions (**Table 4-22**). After review and approval of these petitions the SWRCB then issues a Temporary Urgency Change Order (TUCO).

Prior to 2017, TUCOs indicated that down-ramping for flow releases during the water supply operations period should be no more than 25 cfs/hour. In 2017, NMFS indicated that the ramping rates for water supply flow releases were subject to take authorization in a letter to the SWRCB in response to Sonoma Water's 2017 TUCP. Furthermore, NMFS indicated that ramping rates during the water supply period were of special concern for adult, kelt, and smolt intra-watershed movement, and may still contribute to fry and juvenile stranding. NMFS indicated that in lieu of take authorization the SWRCB should set ramping rates at a maximum of 12 cfs/hour and no more than 24 cfs/day. The SWRCB subsequently included those revised ramping rates in the 2017 TUCO, and successive TUCOs have also specified these ramping rates.

Fish Habitat Flows and Water Rights Project

As described in Section 3, the *2008 Biological Opinion* indicated that Sonoma Water may develop an alternative minimum instream flow schedule that improves conditions for threatened and endangered salmonids within the Russian River watershed. Furthermore, the *2008 Biological Opinion*'s RPA includes a multiyear process for changing Decision 1610 involving filing a Petition to Change Decision 1610 with the SWRCB, posting Public Notice of this Petition, completing a multiyear EIR for California Environmental Quality Act (CEQA) compliance, and taking part in a hearing process before the SWRCB.

Concurrent with the development of TUCPs with the SWRCB, in order to implement the *2008 Biological Opinion's* RPA, Sonoma Water has been developing the Fish Habitat Flows and Water Rights Project. (Fish Flow Project). Sonoma Water filed a Notice of Preparation (NOP) for the Fish Flow Project EIR in September 2010 and filed petitions with the SWRCB to permanently change its water rights. Sonoma Water also published a Draft EIR for the project in August 2016. See Section 3.2.2.2, *Preliminary Fish Flow Project Water Supply Releases and Minimum Instream Flows*, for additional discussion.

TABLE 4-22
SUMMARY OF TEMPORARY URGENCY CHANGE PETITIONS TO THE CALIFORNIA STATE WATER RESOURCES BOARD FILED BY SONOMA WATER SINCE 2008

Year	Order[a]	Order Date	Purpose	Permits	Upper Russian River (cfs)	Lower Russian River (cfs)	Lower Dry Creek	Applicable Period
2009	WRO 2009-0034-EXEC (supersedes WRO 2009-0027-DWR)	-	Predicted low reservoir conditions; hydrologic index not reflecting watershed conditions	12947A, 12949, 12950, 16596	75	85	No change	4/6/2009-10/2/2009
2010	WRO 2010-0018-DWR	-	2008 Biological Opinion Compliance	12947A, 12949, 12950, 16596	125	70	No change	5/25/2010-10/15/2010
2011	Order dated 6/1/2011 by B. Evoy	6/1/2011	2008 Biological Opinion Compliance	12947A, 12949, 12950, 16596	125	70	No change	6/1/2011-10/15/2011
2012	Order dated 5/1/2012 by B. Evoy	5/2/2012	2008 Biological Opinion Compliance	12947A, 12949, 12950, 16596	125	70	No change	5/2/2012-10/15/2012
2013	Order dated 5/1/2013 by B. Evoy	5/1/2013	Prevailing Drought Conditions	12947A, 12949, 12950, 16596	75 (25)[b]	85 (35)[b]	No change	5/1/2013-10/28/20158
2013[c]	Order dated 12/31/2013 by J. Kassel for B. Evoy; Amended Order issued 3/7/2014	3/7/2014	Predicted low reservoir conditions; hydrologic index not reflecting watershed conditions	12947A	NA	NA	No change	1/1/2014-6/29/2014
2014	Order dated 8/25/2014 by M.W. for B. Evoy	8/25/2014	Predicted low reservoir conditions in Lake Mendocino	12947A, 12949, 12950, 16596	50	60	No change	8/25/2014-2/20/2015
2015	Order dated 5/1/2015 by J.O. for B. Evoy; Amended Order issued 6/17/2015	6/17/2015	Predicted low reservoir conditions in Lake Mendocino; Order amended upon SCWA request due to changes in PG&E PVP operations	12947A, 12949, 12950, 16596	75 (25)[d]	85 (50)[e]	No change	5/1/2015-10/27/2015
2016	Order dated 5/4/2016 by B. Evoy	5/4/2016	2008 Biological Opinion Compliance	12947A, 12949, 12950, 16596	125	70	No change	5/1/2016-10/27/2016
2017	Order dated 5/19/2017 by L. Grober	5/19/2017	2008 Biological Opinion Compliance	12947A, 12949, 12950, 16596	125	70	No change	5/19/2017-10/15/2017
2019	Order dated 6/20/2019 by E. Ekdahl	6/20/2019	2008 Biological Opinion Compliance	12947A, 12949, 12950, 16596	125	70	No change	6/20/2019-10/15/2019
2020	Order 2020-0102-EXEC dated 7/28/2020 by E. Sobeck	7/28/2020	Predicted low reservoir conditions in Lake Mendocino	12947A, 12949, 12950, 16596	50	60	No change	7/28/2020-12/27/2020
2021[b]	Order dated 2/4/2021 by E. Ekdahl; Amended Order issued 2/11/2021	2/11/2021	Predicted low reservoir conditions; hydrologic index not reflecting watershed conditions	12947A	NA	NA	No change	2/4/2021-6/14/2021

TABLE 4-22
SUMMARY OF TEMPORARY URGENCY CHANGE PETITIONS TO THE CALIFORNIA STATE WATER RESOURCES BOARD FILED BY SONOMA WATER SINCE 2008

Year	Order[a]	Order Date	Purpose	Permits	Upper Russian River (cfs)	Lower Russian River (cfs)	Lower Dry Creek	Applicable Period
2021	Order 2021-0056-EXEC dated 6/14/2021 by S. Boland-Brien	6/14/2021	Prevailing drought conditions, extreme low storage conditions in Lake Mendocino, 2008 Biological Opinion Compliance	12947A, 12949, 12950, 16596	25	35	No change	6/14/2021-12/10/2021
2022	Order dated 6/17/2022 by E. Ekdahl	6/17/2022	Prevailing drought conditions, low reservoir levels, hydrologic index not reflecting watershed conditions, and 2008 Biological Opinion Compliance	12947A, 12949, 12950, 16596	23	35	No change	6/17/2022
2022	Order dated 12/14/2022 by E. Ekdahl	12/14/2022	Prevailing drought conditions, low reservoir levels, hydrologic index not reflecting watershed conditions, PVP flow reductions, and 2008 Biological Opinion Compliance	12947A, 12949, 12950, 16596	Based on index	Based on index	No change	12/14/2022-06/01/2023

NOTES:

[a] As of 2010, SWRCB no longer assigns an Order Number to staff issued Orders

[b] If from July 1 to October 28 storage in Lake Mendocino drops below SCWA's calculated critical storage curve for more than three consecutive days

[c] These TUCP consisted of requests to implement an alternative hydrologic index based on Lake Mendocino storage

[d] 75 cfs from 5/1/2015 to 6/15/2015, and 25 cfs from 6/16/2015 to 10/27/2015

[e] 85 cfs from 5/1/2015 to 6/15/2015, and 25 cfs from 6/16/2015 to 10/27/2015

SOURCES: USACE and SCWA. 2004. Russian River Biological Assessment. Prepared by Entrix Inc. for: U.S. Army Corps of Engineers, San Francisco, CA and Sonoma County Water Agency, Santa Rosa, CA. Sept. 29, 2004.

SCWA, 2009-2022. Petitions for Temporary Urgency Change. Permits 12947A, 12949, 12950 and 16596 (Applications 12919A, 15736, 15737 and 19351). Filed with the State Water Resources Control Board.

Specific Fish Flow Project flow schedules and associated indices are subject to future revision based on ongoing discussions between Sonoma Water, USACE, and resource agencies, including NMFS, and may be modified through preparation of the recirculated Draft EIR in response to public and resource agency comments received on the Draft EIR, and revisions based on development of modeling scenarios that reflect reasonably foreseeable likely future PVP operations.

4.6.1.3 Turbidity

The *2008 Biological Opinion* concluded that CVD flood control and water supply operations results in increased turbidity levels downstream, which could have an adverse effect on incubating and rearing Chinook Salmon and steelhead. In response, the *2008 Biological Opinion* included RPM-4 designed to address turbidity to minimize reservoir flood control and water supply operations impacts on salmonids below CVD.

RPM-4 and its current status is summarized briefly below:

- **RPM-4**: Undertake measures to assist NMFS in determining the amount of take resulting from turbidity releases at CVD.

RPM-4 focused on more precisely quantifying the impact of turbidity from CVD on salmonid emergence, growth, and survival. CVD contributes to persistent elevated turbidity in the Russian River, which may adversely affect steelhead and Chinook Salmon eggs and alevins within gravel substrates, or rearing juveniles. USACE was directed to install turbidity monitoring meters at existing U.S. Geological Survey (USGS) gages, conduct a bathymetric survey of Lake Mendocino, and develop and implement a plan to minimize incidental take.

The USACE contracted with Bestor Engineers, Inc. for the bathymetric survey of Lake Mendocino. The original scans are dated July 7, 2010, and the scans and post-processed data (CAD files, etc.) are in USACE's possession. Additionally, USACE collected turbidity data at the following locations in the Russian River:

- USGS Gauge No. 11461000 on mainstem Russian River (West Fork; 2008-2014)
- USGS Gauge No. 11461500 East Fork Russian River above Lake Mendocino (2008-2017)
- USGS Gauge No. 11462000 East Fork Russian River below Coyote Valley Dam (2008-2018)
- USGS Gauge No. 11462080 on mainstem Russian River near Talmage (2012-2018)

In recent USACE reports to NMFS, USACE included turbidity data collected by USGS at Hopland (2002-2021; Gauge No. 11462500), Jimtown (2009-2021; Gauge No. 11463682), and Dry Creek at Lambert Bridge (2012-2021; Gauge No. 11465240) as discussed below. Due to the complexity of the problem, USACE has convened a Technical Advisory Committee (TAC) to assist in developing and implementing a plan to minimize and avoid adverse effects from turbidity (see Section 3.2.2.4, *Lake Mendocino Turbidity Management*). The TAC has met twice in 2023 and it has become apparent that both short term avoidance and minimization measures, and investigation of a potential long-term solution to reduce elevated turbidity levels, are necessary. USACE will enlist the assistance of two peer reviewers of TAC decisions and products who have expertise with turbidity and/or suspended sediment dynamics in reservoirs and rivers impacted by dams. USACE will issue a final turbidity report analyzing the existing turbidity data and transmit the final turbidity report to the TAC. Turbidity monitoring will be continued. USACE will request that the TAC provide a definition of "baseline" turbidity and in turn, the TAC will assist USACE with identifying the conditions which cause turbid water to be released from CVD (e.g., flow "thresholds," needle valve or gate position, power generation, etc.).

USACE recently analyzed the turbidity data collected in the Russian River and provided initial analysis, interpretation, and summaries for selected years and locations. The USACE assessment found that measurements collected at six stations between 2012 and 2021 (Calpella, CVD Dam Outlet, Hopland, West Fork, and Jimtown in the Russian River, and Lambert Bridge on Dry Creek) consistently identified high levels of turbidity tied to releases from CVD.[225] However, the exact mechanism controlling the turbidity resulting from reservoir releases, and the extent of downstream effects, remains unclear. Differences in turbidities were evident from the comparisons of all six sites. Importantly, turbidity data was not collected on the same days or even in the same years across monitoring stations. Therefore, despite turbidity being highest at the stations in closest proximity to the release point, turbidity effects from CVD releases on downstream locations remain difficult to quantify.

The pattern of turbidity threshold exceedance was less clear but still occurred more often at sites closest to the release point. These data were assessed by season, but again often were not collected on the same days or in the same years. When compared to typical permit standards, turbidity measured at the Dam Outlet was ≥ 10 Nephelometric Turbidity Units (NTU) over the West Fork 85 percent of the time (404 days) and Hopland was ≥ 10 NTU over the West Fork 14 percent of time (69 days). USACE recommended that additional intra-seasonal analysis incorporating CVD operations data may be helpful in identifying the timing, sources, and mechanisms controlling the releases of turbidity from the Dam Outlet. The USACE also recommended additional actions to better define the turbidity issues related to releases from CVD, all of which are included in the project description (Section 3.2.2.4, *Lake Mendocino Turbidity Management*).

NMFS provided extensive comments on the above analysis including the conclusion that some of the turbidity measurements collected at the West Fork and Dam Outlet were flawed.

To address the data quality issue, USACE has conducted additional analysis and is preparing an addendum to the report focused on turbidity comparisons that were obtained when West Fork flows were at least 10 cfs or greater and 10 percent of the CVD flow or greater. This approach eliminated a large number of 0 or 1 NTU measurements obtained during the annual low flow periods when little or no flow was measured in the West Fork. The USACE separately addressed flow and turbidity from CVD during the low flow periods. Additionally, USACE ensured that turbidity measurements greater than 950 NTU were removed from the data set for the West Fork and CVD as stated in the original report. These high turbidity measurements are considered faulty

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[225] USACE, 2022. Russian River Turbidity Assessment and Proposed Plan – Sonoma County and Mendocino County, California. San Francisco Env. Services Branch. March 2022.

(but see brief discussion below); the 950 NTU cutoff was used because that was the highest turbidity recorded at Hopland by the USGS for the original period of the data analyzed. The USACE assessed the turbidity data by season (i.e., winter, spring, summer, and fall) but also considered two scenarios when elevated turbidity from CVD releases has been noted as being a concern: (1) when flows from the West Fork have declined following winter rainstorms but flood control releases from CVD continue, and (2) when summer flows, although lower than winter flows, are driven by CVD releases alone as is typical.

In winter 2012-13 median turbidity was 17 NTU at Hopland, 2 NTU at West Fork, and 58 NTU at CVD outlet. However, maximum recorded turbidity was 826 NTU at West Fork versus 366 NTU at CVD outlet. These and other spiking turbidity levels could have been errors in the data. However, they were not uncommon and often were correlated with flow. Future monitoring should determine whether these spikes actually occur. In winter 2014, median turbidity was 6 NTU at Hopland, 12 NTU at West Fork, and 24 NTU at CVD outlet, but the maximum recorded turbidity was much higher at West Fork than CVD outlet (524 vs 47 NTU).

Periodic elevated flows indicate that winter storms occurred during the winters of 2012-13 and 2014. Simple inspection of flow and turbidity after these events indicated that turbidity in the West Fork following the only winter storm during the week of Christmas 2012 declined to about 10 NTU within 10 days and continued declining to about 5 NTU by mid-January and about 1 NTU by the end of January. Flow in the West Fork also declined during this period from a high of 3,928 cfs to about 30 cfs; flow and turbidity were highly correlated. In contrast, increased flow at the CVD outlet was delayed and then remained high through about New Years Day 2013. Although flow declined to about 150 cfs in the first week of January and remained at 140-150 cfs for the rest of the winter, turbidity at the CVD outlet following the storm declined to about 80, then 70, then 60 NTU through January, and then was somewhat erratic with periods of about 50-60, then 5, and finally 20-25 NTU at the end of the winter in March. Flow and turbidity at the CVD outlet were not significantly correlated. Winter 2012-13 is a good illustration of the first scenario of concern identified above.

A different pattern was evident in winter 2014, for which only data exists for February and March when two storms occurred. West Fork flow and turbidity were again highly correlated and responded as expected with notable increases and decreases, and by the end of winter West Fork flow was about 50 cfs and turbidity was 2 NTU. In contrast, flow and turbidity at the CVD outlet generally were about 20 cfs and 25 NTU, respectively, and were relatively stable throughout the entire period.

Turbidity was compared in three spring periods (2012-14) to examine the second scenario of concern identified above because little or no flow occurred in the West Fork in any of the summers for which data existed. In general, by the end of spring for all three years, flow in the West Fork declined to about 10-15 cfs and turbidity declined to about 1 NTU. At the CVD outlet, by the end of both spring 2012 and spring 2013, flow was relatively stable at about 115 and 100 cfs, respectively, as was turbidity at about 17 and 15 NTU, respectively.

Spring 2014 was different in that flow was relatively stable but much lower at about 20 cfs throughout the period, and turbidity fluctuated widely during the period including at the end and ranged from about 10 to 612 NTU. As noted above, these data could be faulty; however, if they are not, they suggest factors other than flow alone may affect turbidity at the CVD outlet. Additional inspection of summer flow and turbidity data from the CVD outlet when there was little or no West Fork flow indicate similar numbers for 2012, but somewhat increased flow (e.g., 125-150 cfs) and turbidity (e.g., 20-25 NTU) with some large spikes (e.g., 200-600 NTU) for 2013. For 2014, flow generally measured about 125 cfs during the summer, but turbidity fluctuated with 1-3 week-long periods of about 30-70 NTU and 100-500 NTU. As an estimate of the downstream extent of effects, turbidity at Hopland was much more consistent among these years 2012-2014, and measured from 5 to 10 NTU in late spring and summer 2012 and 2013 and from 1 to 7 NTU in late spring and summer 2014.

4.6.2 Lake Sonoma and Warm Springs Dam

Lake Sonoma is located approximately 16 km northwest of the City of Healdsburg in Sonoma County, California, on Dry Creek, a tributary to the Russian River. Lake Sonoma is created by Warm Springs Dam. The watershed contributing to Lake Sonoma encompasses an area of 337 km^2, which is approximately nine percent of the Russian River watershed. The average water year inflow into Lake Sonoma is approximately 170,000 acre-feet per year, with a peak water year inflow of 392,000 acre-feet in 1995 and a minimum of 10,000 acre-feet in 2021. All of the reservoir inflows come from unimpaired flows.

4.6.2.1 Flood Control Operations

The USACE oversees flood control operations at WSD at Lake Sonoma in accordance with the WCM. The WCM for WSD and Lake Sonoma was released in September 1986, and flood control operations are delineated in Exhibit A. *Standing Instructions to Damtenders*.[226] USACE also conducts annual pre-flood release inspections and periodic five-year inspections of the release facilities at WSD. The rate at which water is released from each reservoir during inspections is specified by the operational guidelines for flood releases, annual pre-flood inspections, and periodic five-year inspections.

4.6.2.2 Water Supply Operations

At Lake Sonoma the water conservation pool holds 245,000 acre-feet which constitutes the principal municipal, domestic, and industrial water supply for Sonoma Water customers in much the Russian River basin, and parts of Sonoma and Marin counties.[227,228] The Lake Sonoma Pool Schedule is shown below in **Figure 4-29**.

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[226] USACE, 1986. Coyote Valley Dam and Lake Mendocino, Russian River, California: Water Control Manual. Appendix I to the Master Water Control Manual, Russian River Basin. September 1986.

[227] SWRCB. 1986. Russian River project: Application 19351 and petitions on permits 12947A, 12949, 12950, and 16596 issued on applications 12919A, 15736, 15737, and 19351 of Sonoma County Water Agency, East Fork Russian River, Russian River, and Dry Creek in Mendocino and Sonoma Counties. Sacramento (CA): State Water Resources Control Board. Decision 1610. State Water Resources Control Board.

[228] NMFS, 2008. *Op. cit.*

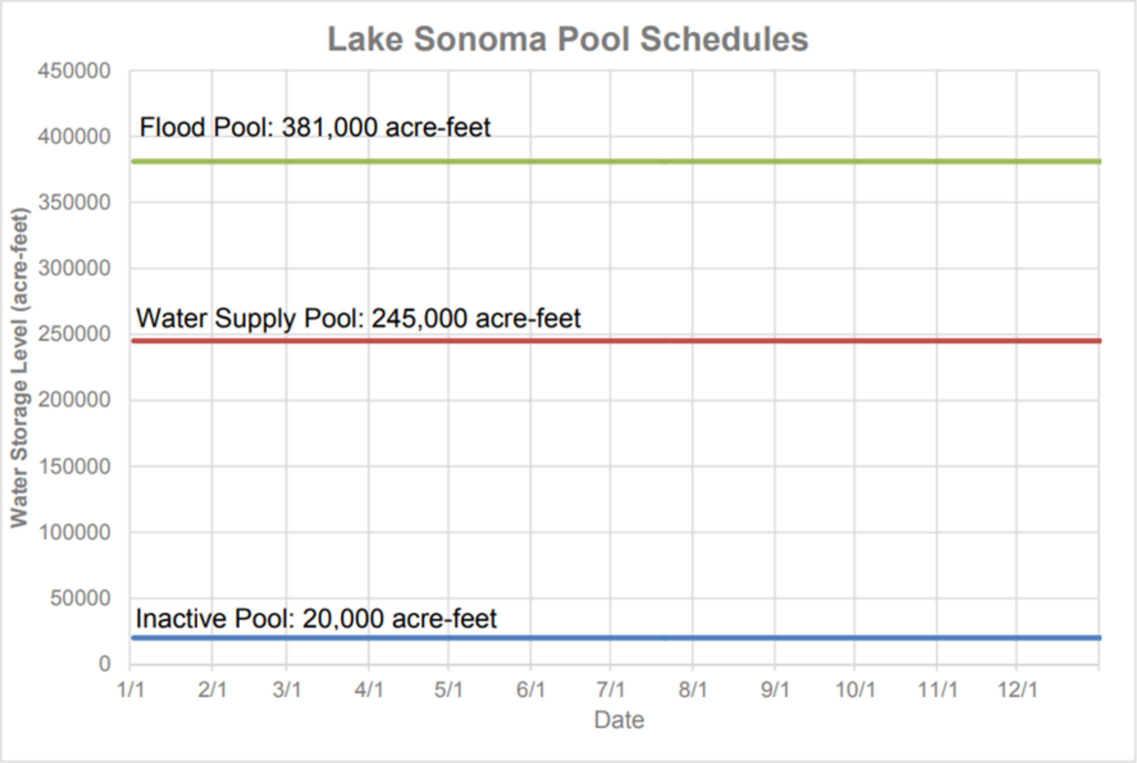

Figure 4-29
Lake Sonoma Flood Control and Water Supply Pool Schedules

Sonoma Water has the only permit authorized to re-divert stored water released from Lake Sonoma. As such, only cities and districts with water supply agreements with Sonoma Water can re-divert stored water released from Lake Sonoma. These operational protocols are dictated by the need to preserve the maximum amount of water in the Lake Mendocino water conservation pool due to its smaller capacity and greater susceptibility to dry watershed conditions including reductions of the Potter Valley Project imports of Eel River water.

4.6.3 Water Right Permits

Sonoma Water manages water supply releases from CVD and WSD under water right permits originally issued by the SWRCB in Decision 1030 (adopted on August 17, 1961), and then modified by Decision 1416 (adopted on March 15, 1973), Order WR 74-30 (adopted on October 17, 1974), Order WR 74-3 (adopted on November 21, 1974), and Decision 1610 (adopted on April 17, 1986). Sonoma Water holds Permit 12947A for the storage of water in Lake Mendocino and for direct diversion and re-diversion of water originating in the East Fork Russian River at its Wohler/Mirabel diversion facilities and other points of diversion by cities and districts that have water supply agreements with Sonoma Water. Under Permit 12947A, the combined direct diversion and re-diversion rates are limited to an average monthly rate of 92 cfs and up to 37,544 acre-feet per year (AFY). Sonoma Water holds Permit 16596 for storage of water at Lake Sonoma and direct diversion and re-diversion of up to 180 cfs from the Russian River at the Wohler/Mirabel diversion facilities and other customer locations. Sonoma Water also holds water right Permits 12949 and 12950 for direct diversion of 20 and 60 cfs, respectively, at the Wohler/Mirabel diversion facilities and other points of diversion by cities and districts that have water supply agreements with Sonoma Water.

Water Right Permit 12947A authorizes Sonoma Water to store up to 122,500 AFY of water in Lake Mendocino and Permit 16596 authorizes Sonoma Water to store up to 245,000 AFY of water in Lake Sonoma. The combined amount of direct diversion and re-diversion authorized under Sonoma Water's four permits (12947A, 16596, 12949, and 12950) is limited to no more than 180 cfs (116.3 million gallons per day [mgd]) and 75,000 acre-feet per WY. The authorized points of diversion in these permits include Sonoma Water's Wohler/Mirabel diversion facilities and facilities of its Russian River customers. In Decision 1610, the SWRCB specified a deadline of December 1, 1999, for Sonoma Water to complete full beneficial use of water under the permits. This deadline is specified in Term 8 of Permits 16596 and 12947A, and Term 6 of Permits 12949 and 12950.

As described previously, the Decision 1610 minimum instream flow requirements are included in terms of Sonoma Water's water right permits. Decision 1610 minimum instream flow requirements for the upper Russian River and lower Russian River are included in Term 20 of Sonoma Water's water right Permit 12947A. Minimum instream flow requirements for the lower Russian River are also included in Term 17 of Permits 12949 and 12950. Decision 1610 minimum instream flow requirements for Dry Creek and the lower Russian River are included in Term 13 of Permit 16596. Decision 1610 also authorized Redwood Valley County Water District (RVCWD) to divert up to 7,500 acre-feet of water from Lake Mendocino under Sonoma Water's Permit 12947A, under specific conditions. Any water diverted under Sonoma Water's Permit 12947A may be used only within the RVCWD boundaries as they existed in 1986. Currently, the RVCWD is not diverting any water under Sonoma Water's permit and Sonoma Water does not have an active water supply agreement with RVCWD.

Decision 1030 reserved 10,000 AFY of water from Lake Mendocino for diversions for domestic and agricultural uses within the Russian River valley of Sonoma County.[229] Diversions and uses of water under this reservation are reported by the individual water right holders. Decision 1030 concluded that there should be sufficient water reserved for use within the Russian River valley to meet future requirements for 10 years, after which, any water not contracted should be made available elsewhere. In Order WR 74-30, the SWRCB ordered that Sonoma Water's appropriative water right permit be amended to depletion by diversion of project water not to exceed 10,000 AFY, eliminated the 10-year time limit, and allowed individuals to file applications with the SWRCB to appropriate up to 10,000 AFY for agricultural and domestic purposes within the Russian River valley for uses beginning after January 28, 1949. Decision 1610 did not change provisions of this order pertaining to the 10,000-acre-foot reservation.

4.6.3.1 Decision 1610

Decision 1610 established minimum instream flow requirements for the Russian River and Dry Creek, which are included as terms of Sonoma Water's water right permits (see Section, *Water*

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[229] This reservation is commonly referred to as the "10,000-acre-foot reservation."

Right Permits). The minimum instream flows requirements were established for four reaches in the Russian River watershed: (1) East Fork Russian River from CVD to the confluence with the Russian River; (2) the Russian River between the East Fork confluence and Dry Creek; (3) the Russian River between Dry Creek and the Pacific Ocean; and (4) Dry Creek downstream of WSD to the confluence with the Russian River.

The SWRCB's Decision 1610 also approved a hydrologic index for the Russian River watershed, which defines a hydrologic condition based on cumulative inflow into Lake Pillsbury in the Eel River watershed beginning on October 1 of each year.[230] Thresholds of cumulative Lake Pillsbury inflow are defined for the first of each month from January 1 to June 1 to determine the hydrologic condition. The Decision 1610 Hydrologic Index defines cumulative inflow into Lake Pillsbury as the algebraic sum of releases from Lake Pillsbury, change in storage, and lake evaporation. The Decision 1610 Hydrologic Index includes three water supply hydrologic conditions: *Normal*, *Dry*, and *Critical*. These conditions are each used to determine a corresponding schedule of minimum instream flow requirements for the upper Russian River, the lower Russian River,[231] and Dry Creek.[232]

Normal water supply conditions exist whenever a *Dry* or *Critical* water supply condition is not present.

Dry water supply conditions exist when cumulative inflow to Lake Pillsbury from October 1 to the date specified below is less than:

- 8,000 acre-feet as of January 1;
- 39,200 acre-feet as of February 1;
- 65,700 acre-feet as of March 1;
- 114,500 acre-feet as of April 1;
- 145,600 acre-feet as of May 1; and
- 160,000 acre-feet as of June 1.

Critical water supply conditions exist when cumulative inflow to Lake Pillsbury from October 1 to the date specified below is less than:

- 4,000 acre-feet as of January 1;
- 20,000 acre-feet as of February 1;
- 45,000 acre-feet as of March 1;
- 50,000 acre-feet as of April 1;

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[230] Water year is defined as the 12-month period beginning on October 1 for any given year and ends September 30 of the following year. The water year designation is defined as calendar year in which it ends. For example, water year 2016 began on October 1, 2015, and ends September 30, 2016.

[231] Lower Russian River is defined as the Russian River from its confluence with Dry Creek to the Pacific Ocean.

[232] These requirements apply to the reach of Dry Creek between Warm Springs Dam and its confluence with the Russian River.

- 70,000 acre-feet as of May 1; and
- 75,000 acre-feet as of June 1.

The Decision 1610 minimum instream flow requirements require a minimum flow of 25 cfs in the East Fork Russian River from Coyote Valley Dam to its confluence with the West Fork Russian River under all water supply conditions. From this point to Dry Creek, the required upper Russian River minimum instream flows are 185 cfs from April 1 through August 1 and 150 cfs from September 1 through March 31 during *Normal* water supply conditions, 75 cfs during *Dry* conditions, and 25 cfs during *Critical* conditions.

The Decision 1610 minimum instream flow requirements further specify two variations of the *Normal* water supply condition, commonly known as *Normal Dry Spring 1* and *Normal Dry Spring 2*. These conditions provide for lower minimum instream flow requirements in the upper Russian River from the confluence of the East and West Forks to the Russian River's confluence with Dry Creek during times when the combined storage in Lake Pillsbury and Lake Mendocino on May 31 is unusually low. This Dry-Spring provision does not make any changes in minimum instream flow requirements in the lower Russian River or Dry Creek. *Normal Dry Spring 1* conditions exist if the combined storage in Lake Pillsbury and Lake Mendocino is between 150,000 acre-feet or 90 percent of the estimated total water supply storage capacity of the reservoirs, whichever is less, and 130,000 acre-feet or 80 percent of the estimated total water supply storage capacity of the reservoirs, whichever is less, on May 31. Under *Normal Dry Spring 1* conditions, the required minimum instream flow in the upper Russian River between the confluence of the East Fork and West Fork and Healdsburg is 150 cfs from June 1 through March 31, with a reduction to 75 cfs from October 1 through December 31 if Lake Mendocino storage is less than 30,000 acre-feet during those months. *Normal Dry Spring 2* conditions exist if the combined storage in Lake Pillsbury and Lake Mendocino is less than 130,000 acre-feet or less than 80 percent of the estimated total water supply storage capacity of the reservoirs on May 31. Under *Normal Dry Spring 2* conditions, the required minimum instream flows in the upper Russian River are 75 cfs from June 1 through December 31 and 150 cfs from January 1 through March 31.

The required minimum instream flows in the lower Russian River from Dry Creek to the Pacific Ocean are 125 cfs during *Normal* water supply conditions, 85 cfs during *Dry* conditions, and 35 cfs during *Critical* conditions.

The required minimum instream flows in Dry Creek below Warm Springs Dam are 75 cfs from January 1 through April 30, 80 cfs from May 1 through October 31, and 105 cfs from November 1 to December 31 during *Normal* water supply conditions. During *Dry* and *Critical* conditions, these required minimum flows are 25 cfs from April 1 through October 31 and 75 cfs from November 1 through March 31.

4.6.4 Water Supply Facilities

Sonoma Water's water supply facilities are comprised of water diversion and treatment facilities and a transmission system that delivers water to customers. Sonoma Water maintains its water diversion facilities at its Wohler and Mirabel properties, located near the community of Forestville in Sonoma County, California. The Wohler and Mirabel facilities are located on the lower Russian River, approximately 10 km downstream of the Russian River's confluence with Dry Creek. Sonoma Water's diversion facilities divert Russian River underflow, and these diversions are authorized by and reported as diversions under Sonoma Water's permitted surface water rights.

Sonoma Water operates six radial collector wells at the Wohler and Mirabel production facilities. The first two collector wells (Collectors 1 and 2) were constructed in the late 1950s near Wohler Bridge. Collectors 3, 4, and 5 were constructed near Mirabel Park between 1975 and 1983. Collector 6, located in the Wohler area, was completed in 2006. Each collector well consists of a 13- to 18-foot-diameter concrete caisson extending vertically approximately 60 to 110 feet into the alluvial aquifer. Horizontal perforated intake laterals extend radially from the bottom of each caisson into the aquifer. Each collector well houses two vertical turbine pumps driven by electrical motors. During peak demand months, Sonoma Water raises an inflatable dam on the Russian River near Mirabel, which allows for operation of five infiltration ponds at Mirabel, which increase the area of infiltration along the Russian River. Water backs up behind the inflatable dam and is diverted into the infiltration ponds to recharge the aquifer in the vicinity of Collectors 3, 4, and 5. Backwater conditions along the river also result in increased infiltration in the Wohler area, thereby enhancing the production capacities of Collectors 1, 2 and 6.

In addition to Collectors 3, 4 and 5, Sonoma Water maintains seven vertical wells, referred to as the Russian River Well Field, located at the Mirabel area. These wells are not operated as primary production facilities, but are maintained for standby emergency production. Water pumped by the collector wells is naturally filtered as it travels through the sands and gravels of the aquifer into the collectors and wells and requires no additional treatment besides disinfection and pH adjustment. Sonoma Water operates two corrosion control facilities (pH adjustment), one at Wohler and one on nearby River Road, to treat water in the water transmission aqueducts to control corrosivity in end user's plumbing. In addition to the Wohler and Mirabel water supply facilities, Sonoma Water operates three vertical groundwater wells adjacent to the Russian River-Cotati Intertie pipeline (aqueduct) in the Santa Rosa Plain. These wells are the Occidental Road well, Sebastopol Road well, and Todd Road well. Sonoma Water's water transmission system delivers water to its customers in Sonoma and Marin counties. The water transmission system is comprised of pipelines (aqueducts), storage tanks, booster pump stations, and other appurtenances.

4.6.4.1 Wohler Infiltration Ponds Decommissioning

RPM 6 in the *2008 Biological Opinion* required that measures be undertaken to ensure that harm and mortality to listed salmonids from diversion operations, maintenance and fish screen replacement at Wohler and Mirabel are low. As part of the RPM's Terms and Conditions (Item C), Sonoma Water was required to decommission or modify the infiltration ponds on the east side of the Russian River at the Wohler facility (Project) to prevent fish entrapment in the ponds during flood events.

Infiltration Ponds 1 and 2 were originally constructed as an aid to water supply for Sonoma Water's radial collector wells 1 and 2. Each pond was individually connected to the Russian

River by a channel and each channel was equipped with a manual valve that controlled the inflow/outflow of water when the Russian River water levels were moderate. However, during flood events, the infiltration ponds could overtop and trap salmonids when flood waters receded. As flood waters receded, fish could be entrapped in the ponds due to poor grading within the ponds as well as the channels. This inability to drain caused fish to be stranded and could result in mortality unless fish were rescued.

Sonoma Water determined that decommissioning the infiltration ponds provided the best approach to meeting the intent of RPM 6, Item C. To decommission the ponds and minimize environmental impacts, Sonoma Water removed the manual valves and re-graded the ponds and channels so that all water that enters the ponds during flood events drains as the water recedes. With the large volume of each pond and the significant amount of soil necessary for re-grading, Sonoma Water graded each pond at a slope of one percent toward the river. A one percent slope allows the ponds to fill with water during flood events and drain at the same rate as the receding river.[233]

Decommissioning was initiated in in July 2011 and was completed in October 2011.[234] With completion of the project, ponding within the infiltration ponds no longer occur and salmonids can no longer be trapped once the flood waters recede. In addition, Sonoma Water conducts periodic maintenance of each pond to ensure the proper grading is met and appropriate drainage maintained.

4.6.5 Gravel Bar Grading

Historically, infiltration capacity at the Wohler and Mirabel diversion facilities was augmented by periodically re-contouring gravel bars in the Russian River upstream and downstream of the inflatable dam. While Sonoma Water no longer conducts grading at gravel bars in the Mirabel and Wohler area for infiltration capacity, grading and gravel removal is sometimes required at the diversion facility following large depositional events as result of prolonged and elevated winter flows.

After most winter high flow seasons, inflation of the Mirabel Dam has not been problematic. Generally, some deposition of material on top of the dam has occurred, but not in a significant enough amount to prevent the dam from being inflated. However, in recent years, Sonoma Water staff have noted that larger amounts of material have been deposited on the dam more frequently after winter high flow events, necessitating the removal of material before the dam can be raised. This occurred in 2017 and required Sonoma Water to relocate approximately 200 cubic yards of gravel off the left edge of the inflatable dam in order to safely inflate the structure.[235] Again in 2020 an estimated 275 to 350 cubic yards of material was removed off the top of the dam prior to inflation.[236]

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[233] SCWA, 2009. Wohler Ponds Decommissioning Plan. September 24.

[234] CDFW, 2010. Russian River Wohler Infiltration Ponds 1 and 2 Decommissioning Project – Lake and Streambed Alteration Agreement. August 9.

[235] SCWA, 2017. Mirabel Dam Gravel Removal – 2017 Post-Removal Report. May 2017.

[236] SCWA, 2020. Mirabel Dam Gravel Removal – 2020 Post-Removal Report. March 2020.

As part of the Mirabel Dam Fabric Replacement Project in 2021, Sonoma Water removed an area of sedimentation downstream of the dam. It was thought that this nuisance sedimentation was causing a physical obstruction, just downstream of Mirabel Dam, which caused the migrating gravel to start piling up behind the obstruction and on to the dam. Due to the lack of frequent and sustained high flow events, and the over-abundance of gravel in the river (upstream of Mirabel Dam), gravel deposition on top of Mirabel Dam often need to be addressed prior to raising the dam. To address this issue, Sonoma Water removed an estimated 500 to 600 cubic yards of material off the top of the dam in March 2022 and 2023.[237] During each of these removal events work only occurred in areas not inundated by active flow from the Russian River. Similarly, all equipment remained outside the active flow of the Russian River during removal activities. Thus, no dewatering or fish rescues were required to conduct recent gravel removal. The need to periodically remove gravel prior to raising the Mirabel Dam is anticipated to continue to occur in the future.

4.6.6 Lake Pillsbury and the Potter Valley Project

PG&E's PVP directly diverts Eel River water and re-diverts water released from storage in Lake Pillsbury, a reservoir created by the Scott Dam on the Eel River. These diversions and re-diversions occur 19 km downstream from Scott Dam at Cape Horn Dam. The diverted water is conveyed through a diversion tunnel, wood stave conduits, and penstocks to the PVP Powerhouse; which is located in the Russian River watershed. Some of the water discharged from the powerhouse is diverted into canals from which the Potter Valley Irrigation District (PVID) receives water under a water supply agreement with PG&E and its own appropriative water rights license. PVID's water supply contract with PG&E authorizes PVID to receive up to 50 cfs of flows from the PVP. The water discharged from the powerhouse that is not consumptively used by PVID flows down the East Fork Russian River into Lake Mendocino. Historically, the PVP has a maximum flow capacity of approximately 300 cubic feet per second (cfs) and a generation capacity of 9.4 megawatts (MW). Currently the tunnel diversion capacity is limited by the Van Arsdale fish screen to a maximum rate of 240 cfs.

By 1986, the PVP annually had imported, for decades, significant amounts of water diverted from the Eel River watershed to the Russian River watershed that averaged approximately 156,000 acre-feet annually. Subsequent to amendment to PG&E's PVP operating license in the mid-2000s, the average annual transfer declined to approximately 62,000 acre-feet annually.

In October 2021, PG&E announced that the transformer bank at the PVP powerhouse had failed and would need to be replaced in order to convey water through the powerhouse for power generation. This resulted in further reduction to imports of Eel River water to the Russian River watershed. PG&E estimated it will take two or more years to replace the transformer bank at a cost of five to ten million dollars. On March 22, 2023, PG&E submitted a letter to Federal Energy Regulatory Commission (FERC) stating that it would not repair or replace the transformer.

PG&E is currently diverting Eel River water through a bypass around the powerhouse in order to meet their minimum release requirements to the East Fork Russian River and water supply

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[237] SCWA, 2023. Mirabel Dam Gravel Removal – 2023 Post-Removal Report. April 2023.

deliveries to PVID. Based on the time of year and the hydrologic condition, the transfer varies between 45 cfs and 135 cfs.

PVP diversions and operations are regulated by a license issued to PG&E by FERC and serve multiple purposes, including power generation, Potter Valley agricultural irrigation uses, and minimum instream flow releases into the East Fork Russian River.

PG&E began operation of the PVP in accordance with its amended FERC license in 2006, and these new operations substantially reduced the amounts of PVP diversions compared to historical levels. Since the 2007 water year, PVP diversions average about 60,000 acre-feet, approximately 40 percent of the 1922-2006 average. Changes in the seasonal timings of PVP diversions have also affected Lake Mendocino water storage reliability. Reduced inflows in the spring have contributed to declining water supply reliability of Lake Mendocino through the summer months. As a result, Sonoma Water has had to file several TUCPs with the SWRCB to temporarily reduce the minimum instream flow requirements in the Sonoma Water's water right permits as necessary to preserve water supply storage in Lake Mendocino for subsequent downstream beneficial uses.

On May 11, 2022, FERC directed PG&E to propose a schedule for filing a surrender application and decommissioning plan for the PVP. On July 8, 2022, PG&E submitted a plan and schedule to FERC to surrender its license. FERC approved PG&E's schedule and plan on July 29, 2022. Furthermore, in March 2023, PG&E informed FERC that it will no longer close the spillway gates on Scott Dam in the spring due to seismic concerns of dam. This reduced the total storage capacity of Lake Pillsbury from approximately 77,000 acre-feet to approximately 56,000 acre-feet. The reduction in storage capacity going into the summer season has required PG&E to request flow variances (filed on July 31, 2023) to reduce releases from Scott Dam in order to manage the reservoirs cold water pool. Cold water releases are essential for supporting habitat for salmon and steelhead that rear downstream of Scott Dam in the late summer and early fall.

Per FERC's approved schedule, PG&E will submit a final license surrender application and decommissioning plan by January 29, 2025. FERC's license-surrender proceedings will likely take at least several years. Long-term PVP operations, and therefore imports to the Russian River watershed, may not be resolved for more than five years from now.

4.6.7 Dams

As described above, there are two permanent dams and four permitted temporary dams in the Russian River watershed. In addition, there are an unknown number of temporary dams constructed on smaller tributaries. The two principal permanent dams are Coyote Valley Dam (Lake Mendocino) on the East Fork Russian River, and Warm Springs Dam (Lake Sonoma) on Dry Creek. The four temporary summer dams include the Healdsburg Memorial Dam, the Sonoma Water's Mirabel Inflatable Dam near Forestville, and the Johnson's Beach and Vacation Beach dams near Guerneville. The dams at Memorial, Johnson's, and Vacation beaches provide recreational opportunities, while Sonoma Water's Mirabel Inflatable Dam is a water supply facility. The time of year that the temporary dams (excluding the Mirabel Inflatable Dam) may be erected is limited to June 15 through September 30 to minimize impacts to migrating salmonids. Each of the temporary dams is equipped with a fish ladder to allow for the passage of salmon and steelhead (late or early arriving fish that enter the river outside of the normal run timing) as well as native warm water species. The Mirabel Inflatable Dam can be operated at any time of the year. Fish passage at this facility has been monitored since 2000 to ensure that it does not inhibit the upstream or downstream migration of salmonids. The fish ladder on the west side of the river was replaced with a modern design fish ladder to improve the passage of all species past the Mirabel Inflatable Dam. This project was completed in 2016.

4.7 Hydroelectric Facilities

4.7.1 Lake Mendocino Hydroelectric Facility

The Lake Mendocino Hydroelectric Power Plant (LMHPP or hydroelectric facility), owned and operated by the City of Ukiah, was completed in May 1986. Neither Sonoma Water nor the USACE participate in the operation of the LMHPP. The hydroelectric facility was added as an external facility to the downstream base of CVD, which was not originally designed to supply a hydroelectric plant.[238] The LMHPP has a total generation capacity of 3.5 megawatts (MW) through two generators rated at 1 MW and 2.5 MW, respectively. The City of Ukiah is a member of the Northern California Power Authority (NCPA) and operates the project under a 50-year license issued April 1, 1982, by FERC (Project No. 2481-001). The NCPA owns and operates various power generation plants throughout California. The LMHPP supplements other sources within the City of Ukiah's power system and has no contractual minimum output requirements to maintain. Power output is determined by the amount of water released from the dam for water supply, minimum instream flow requirements, and flood control, rather than power generation needs.

The hydroelectric facility became dormant in 1998 due to various design and operational restrictions but was subsequently upgraded with more modern equipment. During 2005, the City of Ukiah worked with NMFS to develop an operations plan to minimize impacts to salmonids in the Russian River during hydroelectric operations. NMFS technical assistance focused on potential effects to salmonids during the transitions between flood and power operations. The City of Ukiah, NCPA, and NMFS established an operations plan that included operation criteria to reduce potential effects to listed salmonids. Previous modifications by the City of Ukiah to the Tainter gate[239] at Lake Mendocino briefly suspended operation of the hydroelectric facility before resuming operations in January 2007.

4.7.2 Warm Springs Dam Hydroelectric Facility

The Warm Springs Dam Hydroelectric Facility (WSDHF) was completed in December 1988. Sonoma Water operates the facility under a 50-year license issued by FERC on December 18, 1984 (Project No. 3351-002). The 3,000-Kilowatt Francis turbine generator has a power rating of 2.6 MW, but generally averages approximately 1.3 MW.[240,241] Energy production varies according to the flow of water through the dam and average annual energy production totals approximately 13.6 Gigawatt hours (GWh). Hydroelectric operation of the dam is conducted by

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[238] City of Ukiah, 1981. Initial Study of the Effect of Lake Mendocino Power Project upon the Environment.

[239] A Tainter gate is a type of radial arm floodgate used in dams and canal locks to control water flow.

[240] USACE, 1984. *Op. cit.*

[241] SCWA, 2016. *Op. cit.*

Sonoma Water in collaboration with USACE.[242] Prior to 2009, electricity produced at the dam was sold to PG&E. However, beginning in 2009, Sonoma Water began selling hydroelectricity to the Power and Water Resource Pooling Authority (PWRPA). Thereby, contributing it to the pool of renewable energy provided by PWRPA for Sonoma Water operations. As of 2015, the hydroelectric facility at WSD provided approximately 27 percent of Sonoma Water's energy. In early 2019, WSDHF was taken offline to facilitate repairs on the low flow bypass gate and to update the automated start-stop and electrical systems. The facility is expected to be back online in 2025 after maintenance and service is completed in 2024. Subsequent to completion of maintenance and service, hydropower generation is expected to resume.

The WSDHF is located within the control structure of the outlet works of WSD. Water from Lake Sonoma flows to the hydraulic turbine via a vertical wet well located in the control structure that draws water from the horizontal, low-flow tunnels. Water from the tunnels travels down the vertical well between approximately 115 and 194 feet into the turbine. Water passing through the turbine flows from the flood control tunnel into a stilling basin located at the base of the dam. From the concrete-lined mouth of the outlet tunnel stilling basin, water flows through a channelized portion of Dry Creek or is diverted for use in DCFH adjacent to WSD. A two-step weir, approximately 18 feet high, is used to reduce the water velocity from the outlet tunnel to keep fish downstream of the dam from entering the outlet.

4.8 Hatchery Operations

Hatchery and out-of-basin salmonid stocks have been planted into the Russian River basin for over a century; primarily for population supplementation and enhancement of recreational fishing.[243] The primary hatchery facility, referred to as Don Clausen Fish Hatchery (DCFH), or Warm Springs Hatchery, is located at the base of WSD. Its satellite facility, known as Coyote Valley Fish Facility (CVFF), is located at the base of CVD. The DCFH and CVFF facilities went into service in 1980 and 1992, respectively. Construction of DCFH was authorized by the Flood Control Act of 1962 with expansion of the facility sanctioned under the Water Resources Development Act of 1974. This expansion was required to compensate for fish losses attributed to the operation of CVD. Both the DCFH and CVFF are owned by USACE and operated by CDFW under contract from USACE. The water supply for DCFH is provided from Lake Sonoma (at WSD) and the water supply for CVFF is provided from Lake Mendocino (at CVD).

Within the RPA and RPM 7 of the *2008 Biological Opinion*, NMFS prescribed a series of actions designed to strengthen the steelhead and Coho Salmon hatchery programs. The RPA stated:

> "*Given the central importance of the RRCSBP [Russian River Coho Salmon Broodstock Program] in efforts to avoid extirpation of CCC Coho Salmon in the Russian River watershed, the Corps will conduct annual genetics analysis and the monitoring and evaluation components of the RRCSCBP at levels consistent with recent historic funding levels...*" (p. 273)

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[242] SCWA, 2016. *Op. cit.*

[243] The relocation of rescued fish and excess spawning stock has also occurred.

The RPA further delineated a series of actions including the genetic assessment and analysis of all hatchery fish, monitoring to evaluate the effectiveness of the program, and an adaptive management process to revise and modify the program if appropriate levels of recovery are not achieved. These actions are codified in a recent Hatchery Genetic Management Plan for the Coho program (See Section 4.8.1, *Coho Salmon Broodstock Program*).

The objective of RPM 7 was to avoid adverse genetic effects to hatchery and wild steelhead from the operation of the DCFH and CVFF steelhead programs. This RPM included annual genetic monitoring of all steelhead spawned at either facility, the inclusion of wild returning steelhead in the spawning program, and the development of HGMP that the outlined operational protocols for minimizing adverse genetic effects (see Section 4.8.2, *Steelhead Integrated Harvest Hatchery Program*).

4.8.1 Coho Salmon Broodstock Program

The Russian River Coho Salmon Broodstock Program (Coho Broodstock Program) was initiated in 2001 at DCFH to prevent extirpation of Coho Salmon in the Russian River basin, and to reestablish self-sustaining runs of Coho Salmon in tributary streams within the watershed. The Coho Broodstock Program constitutes the main hatchery component of State and Federal Coho Salmon conservation efforts in central California and includes:

- broodstock collection and captive rearing;
- capturing and spawning;
- egg incubation and rearing offspring;
- tagging juveniles;
- releasing juvenile and adult life stages; and
- monitoring and evaluating program performance.

The program is intended to aid in the recovery of the Coho Salmon CCC ESU through producing, rearing, and releasing Coho Salmon to supplement naturally spawning populations and re-establish extirpated populations in the Russian River basin and elsewhere in the CCC Coho Salmon ESU.[244] Importantly, the broodstock program contributes to ESU-wide recovery efforts of Coho Salmon in out-of-basin streams by releasing adults and juveniles in excess of hatchery and broodstock production needs. At present, the program is funded and implemented by USACE with assistance from CDFW. Additional programmatic oversight and adaptive management is provided through regular meetings of a Technical Advisory Committee (TAC) whose members include USACE, CDFW, NMFS, California Sea Grant (CSG), Sonoma Water, and other entities.

Prior to 2001, Coho Salmon were produced at DCFH primarily as part of the USACE Coho Salmon mitigation and enhancement program. Under that program, and other smaller breeding efforts, close to 2.4 million hatchery Coho Salmon were released into the Russian River between

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[244] CDFW & USACE, 2017. *Op. cit.*

1970 and 1998.[245] During this period, at least five out-of-basin Coho Salmon stocks were introduced to the Russian River as a result of out-planting, most of these from hatcheries in the North Coast (**Table 4-23**). Stocking was conducted as part of the USACE Coho Salmon mitigation and enhancement program, as out-of-basin Coho Salmon eggs from the Noyo and Eel rivers were considered acceptable sources for meeting mitigation and enhancement goals. It is estimated that between 1970 and 1998 approximately 32 percent of all releases were from Russian River Coho Salmon broodstock. This program proved to be of limited success and was discontinued after the 1998 release due to the lack of natural- or hatchery-origin Coho Salmon returning to the Russian River watershed for use as broodstock.

TABLE 4-23
COHO SALMON STOCKING HISTORY WITHIN THE RUSSIAN RIVER, 1970-1998

Broodstock Source	Years Released	Total Releases
Russian River	1983, 1985-98	752,372
Alsea River, Oregon	1972	58,794
Eel River	1987, 1990	25,112
Klamath River	1975, 1981-83, 1986-88	451,370
Noyo River	1970, 1972-74, 1982-84, 1986-91, 1993, 1997-98	687,820
Soos Creek, Washington	1978	8,420
Unknown[a]	-	403,340

NOTE:

a With incomplete records, it is assumed that all unknown broodstock sources come from outside the Russian River basin, as was common practice.

SOURCE: CDFW and USACE, 2017. Don Clausen Fish Hatchery: Russian River Coho Salmon Captive Broodstock Program. Hatchery Genetic Management Plan. Prepared for National Marine Fisheries Service. September 2017.

The Coho Broodstock Program as it exists today was initiated in 2001 to address issues with diminished adult returns. Since then, the program has been operated in accordance with conservation hatchery principles, including genetically guided artificial spawning of broodstock to reduce inbreeding. Initially, only natural-origin juvenile Coho Salmon from the Russian River watershed were used as broodstock. In 2008, the broodstock program started systematic outbreeding of Russian River Coho Salmon with out-of-basin stock, resulting in a broodstock derived predominantly from hatchery-reared Coho Salmon retained from artificial propagation at DCFH. A small percentage of broodstock consists of natural origin young-of-the-year (YOY) from various tributaries within the Russian River and Lagunitas/Olema Creek basins as well as the very few Coho Salmon returning to the DCFH as adults.

Since 2004, the Coho Broodstock Program has released over 2 million juvenile Coho Salmon into the mainstem Russian River and tributary streams. Under this program, annual returns of Coho Salmon adults (predominantly hatchery-origin) have increased (**Table 4-24**). From 2005 through 2009, a maximum of five adults were documented over each annual return period. As of the

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[245] Performance standards under this program consisted of 1,000 adults for mitigation and 1,000 adults for enhancement, which required production goals of 110,000 Coho Salmon annually.

2020-21 return season, 214 adult Coho Salmon were estimated to have returned. In recent years, expanded counts have been calculated from antenna detections of Passive Integrated Transponder (PIT) tagged adults returning and the known proportion of PIT-tagged juveniles from each group of hatchery fish released. However, in earlier years, methods of obtaining adult counts include presence/absence surveys, spawner surveys, fishing reports, and video monitoring.

TABLE 4-24
COHO SALMON JUVENILE AND SMOLT RELEASES AND ADULT RETURNS UNDER THE BROODSTOCK PROGRAM, 2003-2019

Hatch Return Years[a]	Juvenile Releases	Adult Returns (Return Year)[b]
2003, 2004	0	2[b] (2005-06)
2004, 2005	6,160	4[b] (2006-07)
2005, 2006	26,059	2[b] (2007-08)
2006, 2007	43,143	5[b] (2008-09)
2007, 2008	71,159	19[b] (2009-10)
2008, 2009	91,482	206[b] (2010-11)
2009, 2010	95,227	401[b] (2011-12)
2010, 2011	155,338	536[c] (2012-13)
2011, 2012	160,397	313[c] (2013-14)
2012, 2013	182,352	397[c] (2014-15)
2013, 2014	171,822	192[c] (2015-16)
2014, 2015	235,324	533[c] (2016-17)
2015, 2016	70,510	763[c] (2017-18)
2016, 2017	158,382	642[c] (2018-19)
2017, 2018	133,849	547[c] (2019-20)
2018, 2019	134,014	214[c] (2020-21)
2019, 2020	194,007	484[c] (2021-22)

NOTES:

a Includes age-0+ spring release, age-0+ fall release, and age-1+ winter and spring release. For a given return year, age-3+ adults were from hatch year-2 and age-2+ adults were from hatch year-1.

b Adult returns are minimum counts from a combination of methods: presence/absence surveys, spawner surveys, fishing reports, video monitoring.

c Expanded counts (adjusted for antenna efficiency) are from PIT detections at the upstream end of the Russian River Estuary in Duncans Mills (rkm 10.46).

SOURCES: CDFW and USACE, 2017. Don Clausen Fish Hatchery: Russian River Coho Salmon Captive Broodstock Program. Hatchery Genetic Management Plan. Prepared for National Marine Fisheries Service. September 2017; California Sea Grant, 2021. Russian River Coho Salmon and Steelhead Monitoring Report: Winter 2020/21. Windsor, CA.

At present, the Coho Broodstock Program has the capacity to accommodate up to 500,000 Coho Salmon eggs, 250,000 progeny (age 0^+ to age 1^+), and 1,500 adults.[246] To operate at this capacity, the broodstock program annually collects up to 1,500 natural-origin YOY and natural-origin adult Coho Salmon for artificial propagation and/or rearing and release. YOY are collected from the

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[246] CDFW & USACE, 2017. *Op. cit.*

Russian River basin or other regional streams while the adults are from fish entering the DCFH volitionally. The program retains approximately 1,500 hatchery-origin YOY Coho Salmon from each spawning event, some or all of which will be used as broodstock in future years. Coho Salmon produced through artificial propagation are released at any life stage, from fry to adult while captive reared, unspawned individuals are released as juveniles, smolts, or adults.

In September 2017, CDFW and USACE finalized a Hatchery Genetic Management Plan (HGMP) for the Coho Broodstock Program in support of their application for Federal Endangered Species Act (ESA) Section 10(a)(1)(A) coverage.[247] The HGMP describes pertinent hatchery activities covered under the Section 10 permit including the collection of natural-origin broodstock, artificial spawning, hatchery rearing, marking and tagging, health maintenance and disease control, program releases, and post-release monitoring (see Section 4.10.3, *Biological Opinion Monitoring*). **Table 4-25** below contains a summary of annual release targets as outlined under the HGMP.

TABLE 4-25
COHO BROODSTOCK PROGRAM MAXIMUM ANNUAL RELEASE TARGETS

Life Stage	Release Number	Release Location	Release Date
Unfed fry and/or eyed eggs	250,000	Russian River tributaries or out-of-basin streams	Feb – Apr
Juveniles (fingerlings, yearlings, and smolts)	250,000	Russian River tributaries or out-of-basin streams	Feb – Mar
Adult	700[a]	Russian River tributaries or out-of-basin streams	Jan – Jun; Oct - Dec

NOTES:
a Only 500 adults may be released in natal or non-natal out-of-basin streams

SOURCE: CDFW and USACE, 2017. Don Clausen Fish Hatchery: Russian River Coho Salmon Captive Broodstock Program. Hatchery Genetic Management Plan. Prepared for National Marine Fisheries Service. September 2017.

4.8.2 Steelhead Integrated Harvest Hatchery Program

Unlike the Coho Broodstock Program, the Steelhead Integrated Harvest Hatchery Program (SIHHP or steelhead program) is designed both to ensure the conservation and recovery of CCC steelhead DPS within the Russian River watershed and to provide fish for angler sport harvest. There are two facilities producing steelhead in the basin: the DCFH and CVFF. Hatchery managers operate the two facilities separately, using adults from different Russian River steelhead populations for broodstock. The CVFF incorporates natural-origin fish from the upper Russian River watershed, while the DCFH facility integrates the steelhead population of Dry Creek. As with the Coho Broodstock Program, a TAC comprised of state and federal resource agencies provides programmatic oversight and adaptive management guidance for the two hatchery programs.

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[247] NMFS issued a federal permit for continued operation of the broodstock program on January 13, 2021.

Prior to the construction of the DCFH and CVFF nearly all stocking of steelhead into the Russian River used broodstock from out-of-basin sources. These historical transfers are recorded as early as the 1890s and included a variety of origins. A history of steelhead stocking, including out-of-basin sources, is summarized in **Table 4-26**.

Since the implementation of the steelhead programs at DCFH (1981) and CVFF (1992), broodstock have been collected solely from fish returning to the Warm Springs fish ladder and Coyote Valley fish ladder, respectively.[248] There have been no releases of out-of-basin steelhead stocks from Warm Springs since 1981 and there have never been any releases of out-of-basin stock from Coyote Valley.

TABLE 4-26
STEELHEAD STOCKING HISTORY WITHIN THE RUSSIAN RIVER, 1911-1998

Broodstock Source	Years Released	Total Releases
Russian River	1959, 1981-98	18,167,885
Eel River	1914-19, 1921-23, 1958-59, 1972	4,900,843
Mad River	1975-76, 1978-79, 1981	324,101
Prairie Creek	1927	249,000
San Lorenzo Creek	1973	83,350
Scott Creek	1911	433,458
Washougal River, Washington	1980-81	270,360
Unknown[a]	-	8,934,122

NOTE:

a. With incomplete records, it is assumed that all unknown broodstock sources come from outside the Russian River basin, as was common practice.

SOURCE: CDFW and USACE, 2021. Russian River Steelhead Integrated Harvest Hatchery Program. Hatchery Genetic Management Plan. Prepared for National Marine Fisheries Service. July 2021.

Between 2006 and 2018, juvenile releases from the DCFH and CVFF have averaged 297,319 and 221,568 individuals, respectively (**Table 4-27**). Juvenile steelhead reared at DCFH were released non-volitionally within mainstem Dry Creek, either at Yoakim Bridge (rkm 17.2) or Well Fields (rkm 21.6). Steelhead reared at CVFF are released into the East Fork of the Russian River. Releases occur in late January to mid-April, with the majority occurring in February and March. Adult steelhead hatchery returns have varied significantly between 2006 and 2017, averaging approximately 3,606 at DCFH and 2,215 at CVFF (**Table 4-28**). In 2009, only 870 and 371 adults were recorded at DCFH and CVFF, respectively.

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[248] The first year of the DCFH steelhead program utilized broodstock collected from Dry Creek and the Mad River Hatchery. Broodstock from Warm Springs were used to initiate the program at CVFF.

TABLE 4-27
STEELHEAD JUVENILE HATCHERY RELEASES, 2006-2018

Release Year	Juvenile DCFH Releases	Juvenile CVFF Releases
2006	300,192	142,382
2007	294,770	202,166
2008	289,878	221,842
2009	310,523	200,956
2010	201,497	221,768
2011	235,033	194,471
2012	319,440	298,019
2013	363,888	246,208
2014	329,690	266,809
2015	319,490	242,327
2016	311,170	245,856
2017	292,260	192,743
2018	-	204,843

SOURCE: CDFW and USACE, 2021. Russian River Steelhead Integrated Harvest Hatchery Program. Hatchery Genetic Management Plan. Prepared for National Marine Fisheries Service. July 2021.

TABLE 4-28
STEELHEAD ADULT RETURNS, 2006-2021

Return Year	Adult DCFH Returns	Adult CVFF Returns
2006	6,785	3,677
2007	6,677	3,745
2008	3,841	3,156
2009	870	371
2010	1,412	859
2011	2,122	1,895
2012	2,213	2,865
2013	4,588	3,633
2014	1,880	2,095
2015	2,179	1,008
2016	4,329	1,342
2017	6,370	1,928
2018	3,052	1,621
2019	7,201	5,330
2020	2,124	1,232
2021	766	562

NOTE: The returns listed above represent all returns (hatchery-origin and natural-origin) to hatchery facilities.
SOURCE: CDFW and USACE, 2021. Russian River Steelhead Integrated Harvest Hatchery Program. Hatchery Genetic Management Plan. Prepared for National Marine Fisheries Service. July 2021.

As with the Coho Broodstock Program, an HGMP for the Russian River steelhead program was completed by CDFW and USACE in July 2021.[249] This document will be used in support of a forthcoming application for Federal Endangered Species Act (ESA) Section 10(a)(1)(A) coverage for the steelhead program. In addition to outlining standard protocols for artificial spawning, hatchery rearing, and post-release monitoring, the steelhead HGMP includes a series of revisions to the release program aimed at reducing predation, competition, and genetic impacts on juvenile Coho Salmon, Chinook Salmon, and steelhead. These revisions include releasing larger steelhead to increase migration speed out of the system, modifying release locations to eliminate predation and competition effects on other salmonids, and limiting the total number of releases from DCFH to reduce genetic risks to the natural population. Additionally, steelhead from both programs will now be released in February and March at the Coyote Valley facility and January through March at the Warm Springs facility, prior to the emergence of Coho Salmon fry. This action is designed to reduce the probability that hatchery steelhead will prey on newly-emerged Coho Salmon. **Table 4-29** contains a summary of annual release targets as outlined under the HGMP.

TABLE 4-29
STEELHEAD PROGRAM MAXIMUM ANNUAL RELEASE TARGETS

Life Stage	Release Number	Release Location	Release Date
Smolt	200,000	Mouth of Dry Creek or Mainstem Russian River	Feb – Mar
Smolt	200,000	Coyote Valley Fish Facility (East Fork Russian River)	Jan – Feb – Mar

SOURCE: CDFW and USACE, 2021. Russian River Steelhead Integrated Harvest Hatchery Program. Hatchery Genetic Management Plan. Prepared for National Marine Fisheries Service. July 2021.

4.8.3 Chinook Salmon

The stocking of Chinook Salmon in the Russian River basin was first reported between 1881 and 1907 and continued sporadically, until the 1950s and 1960s when planting efforts became more concerted with plantings occurring nearly every year between 1982 and 1998.[250,251] The Russian River has received fall Chinook Salmon stocking transfers from a number of sources, including west coast hatcheries in other ESUs; this stocking history is summarized below in **Table 4-30**.

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[249] CDFW & USACE, 2021. Russian River Steelhead Integrated Harvest Hatchery Program. Hatchery Genetic Management Plan. Prepared for National Marine Fisheries Service. July 2021.

[250] Chase, S.D., D.J. Manning, D.G. Cook, and S.K. White, 2007. Historic accounts, recent abundance, and current distribution of threatened Chinook Salmon in the Russian River, California. California Fish and Game 93(3):130-148. 2007.

[251] Myers, J.M, R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grand, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples, 1998. Status review of Chinook Salmon from Washington, Idaho, Oregon, and California. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-35.

TABLE 4-30
CHINOOK SALMON STOCKING HISTORY OF THE RUSSIAN RIVER, 1951-2000

Broodstock Source	Years Released	Total Releases
Klamath River, Sacramento River (Coleman Hatchery)	1951-60	2,250,000
Sacramento River (Coleman Hatchery), unknown	1961-70	1,857,285
Klamath River (Iron Gate Hatchery)	1971-80	73,800
Russian River, Eel River, Mad River, Wisconsin, Sacramento River (Feather River Hatchery), private hatcheries	1981-90	249,000
Russian River, Eel River, Noyo River, Sacramento River (Feather River Hatchery)	1991-2000	349,105

SOURCE: Chase, S.D., D.J. Manning, D.G. Cook, and S.K. White, 2007. Historic accounts, recent abundance, and current distribution of threatened Chinook Salmon in the Russian River, California. California Fish and Game 93(3):130-148. 2007.

The Chinook Salmon hatchery program at the DCFH was started in 1980 with a combination of out-of-basin stocks and Russian River returns. Between 1981 and 1999 this hatchery released more than 2 million fingerlings and yearlings derived from mixed broodstock. Annual juvenile Chinook Salmon releases and adult returns to DCFH varied widely (**Table 4-31**). This hatchery program last released yearlings in 1998 due to low adult returns.[252] At present, no Chinook Salmon hatchery program is in operation.

TABLE 4-31
JUVENILE CHINOOK SALMON RELEASES AND ADULT RETURNS TO DCFH

Year	Juvenile Releases	Adult Returns
1981-82	102,360	0
1982-83	89,650	1
1983-84	66,120	4
1984-85	211,510	8
1985-86	884,520	65
1986-87	126,557	111
1987-88	79,166	304
1988-89	237,450	233
1989-90	49,807	17
1990-91	110,690	99
1991-92	113,525	125
1992-93	8,877	40
1993-94	50,300	21
1994-95	0	85
1995-96	25,923	33

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[252] Good, T.P., R.S. Waples, and P.B. Adams, 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. Commerce, NOAA, NMFS.

TABLE 4-31 (CONTINUED)
JUVENILE CHINOOK SALMON RELEASES AND ADULT RETURNS TO DCFH

Year	Juvenile Releases	Adult Returns
1996-97	31,990	43
1997-98	7,800	49
1998-99	11,730	4

SOURCE: Chase, S.D., D.J. Manning, D.G. Cook, and S.K. White, 2007. Historic accounts, recent abundance, and current distribution of threatened Chinook Salmon in the Russian River, California. California Fish and Game 93(3):130-148. 2007.

4.9 Fish Community

A conservative total of 47 species of fish have been reportedly captured in the Russian River watershed.[253] However, based on sampling conducted by Sonoma Water, the total currently inhabiting the river is closer to 35, with 16 of those native to the mainstem Russian River upstream of the Estuary (**Table 4-32**). In addition, Pink Salmon (*O. gorbuscha*) were reported spawning in the Russian River during the early 1950s, but have rarely been observed since this time and are believed to be extirpated from the watershed.

The Russian River fish assemblage has several species in common with the Sacramento River, suggesting a connection between the two basins in the recent (geologic) past.[254,255,256] Seven of the shared species are intolerant of salt water, and could have only been transferred between basins via a freshwater connection that existed over 10,000 years ago. Species that likely transferred from the Sacramento River to the Russian River are: Sacramento sucker, Sacramento Pikeminnow, Hardhead, California Roach, Tule Perch, Hitch, and Sacramento Blackfish. The Russian River Tule Perch, a subspecies, is the only endemic fish species known to occur in the watershed. Other species native to the Russian River are either anadromous or saltwater tolerant, and therefore could have entered the Russian River from the ocean as well as through a freshwater route. There are two generally accepted pathways whereby obligate freshwater fish species inhabiting the Sacramento River Basin could have gained access to the Russian River[257] Both rely on the connection of a tributary from neighboring watersheds. During the Pleistocene epoch, a well-documented lava flow blocked the outlet of Clear Lake (Cache Creek) which today drains into the Sacramento River. Over time, the lake back filled until it spilled over into the Russian River. The blockage eventually gave way and Clear Lake returned to draining through Cache Creek and into the Sacramento River. The second pathway was through a stream connection between the Petaluma River that flows to San Pablo Bay and Copeland Creek in the Mark West Creek watershed, which are separated by very low divides. During these stream capture events, fish inhabiting the Sacramento Basin could have dispersed into the Russian River.

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[253] Excluding estuarine species.

[254] Snyder, J.O. 1907. The fishes of the coastal streams of Oregon and northern California. Bureau of Fisheries, Washington D.C.: Goverment Printing Office, 153-189.

[255] Hopkirk, J.D. 1973. Endism in fishes in the Clear Lake Region. University of California Publications in Zoology, 1-160.

[256] Moyle, P.B. 2002. *Op. cit.*

[257] Moyle, P.B. 2002. *Op. cit.*

TABLE 4-32
RUSSIAN RIVER WATERSHED FISH COMMUNITY

Common Name	Scientific Name	Origin	Resident-Anadromous
Steelhead	*Oncorhynchus mykiss*	Native	Anadromous
Chinook Salmon	*Oncorhynchus tshawytscha*	Native	Anadromous
Coho Salmon	*Oncorhynchus kisutch*	Native	Anadromous
Pink Salmon	*Oncorhynchus gorbuscha*	Native	Anadromous
Longfin Smelt	*Spirinchus thaleichthys*	Native	Anadromous
Tule Perch	*Hysterocarpus traski*	Native	Resident
Pacific Lamprey	*Entosphenus tridentatus*	Native	Anadromous
Pacific Brook Lamprey	*Lampetra richardsoni*	Native	Resident
Prickly Sculpin	*Cottus asper*	Native	Resident
Riffle Sculpin	*Cottus gulosus*	Native	Resident
Coastrange Sculpin	*Cottus aleuticus*	Native	Resident
Sacramento Sucker	*Catostomus occidentalis*	Native	Resident
Threespine Stickleback	*Gasterosteus aculeatus*	Native	Resident
California Roach	*Lavinia symmetricus*	Native	Resident
Hardhead	*Mylopharodon conocephalus*	Native	Resident
Sacramento Blackfish	*Orthodon microlepidotus*	Native	Resident
Hitch	*Lavinia exilcauda*	Native	Resident
Sacramento Pikeminnow	*Ptychocheilus grandis*	Native	Resident
Fathead Minnow	*Pimephales promelas*	Introduced	Resident
Golden Shiner	*Notemigonus crysoleucas*	Introduced	Resident
Common Carp	*Cyprinus carpio*	Introduced	Resident
Goldfish	*Carassius auratus*	Introduced	Resident
Bluegill	*Lepomis macrochirus*	Introduced	Resident
Green Sunfish	*Lepomis cyanellus*	Introduced	Resident
Redear Sunfish	*Lepomis microlophus*	Introduced	Resident
Black Crappie	*Pomoxis nigromaculatus*	Introduced	Resident
White Crappie	*Pomoxis annularis*	Introduced	Resident
Smallmouth Bass	*Micropterus dolomieu*	Introduced	Resident
Largemouth Bass	*Micropterus salmoides*	Introduced	Resident
Channel Catfish	*Ictalurus punctatus*	Introduced	Resident
White Catfish	*Ameiurus catus*	Introduced	Resident
Black Bullhead	*Ameiurus melas*	Introduced	Resident
Mosquitofish	*Gambusia affinis*	Introduced	Resident
Striped Bass	*Morone saxitalis*	Introduced	Anadromous
American Shad	*Alosa sapidissima*	Introduced	Anadromous
Threadfin Shad	*Dorosoma petenense*	Introduced	Resident
Inland Silverside	*Menidia beryllina*	Introduced	Resident

SOURCE: SCWA, 2016. Fish Habitat Flows and Water Rights Project Draft Environmental Impact Report. July 2016.

4.9.1 Native and Nonnative Predatory Fish

NMFS and CDW have expressed concern regarding the status of both native and nonnative predatory fish and associated effects of predation on outmigrating juvenile salmonids. Two species of particular interest are native Sacramento Pikeminnow and nonnative Smallmouth Bass. The status, life-history, and distribution of these species are discussed in detail in the following sections to provide the background information against which the effects of the Proposed Action are measured. Historical and current monitoring of the fish community, including these two species, is described under Section 4.9.4, *Russian River Watershed Current Fish Monitoring*, below.

4.9.1.1 Sacramento Pikeminnow

The Sacramento Pikeminnow is the largest member of the minnow family (Cyprinidae) inhabiting the Russian River. Pikeminnow are native to the Russian River, Sacramento-San Joaquin River systems, and the Pajaro and Salinas rivers.[258] Prior to the introduction of other predators, Pikeminnow were the dominant piscivore ("fish eater") in the Russian River. Most of what is known about their biology and life history comes from studies conducted in other river systems, primarily in the Sacramento and San Joaquin. In addition, a considerable amount of work has been conducted on the closely related Northern Pikeminnow (*P. oregonensis*) predation on salmonid smolts in the Columbia River Basin.

Historical observations of Sacramento Pikeminnow in the Russian River are limited to Taft and Murphy (1950) and a few CDFW reports, primarily during the 1950s chemical treatment (rotenone) projects. Based on these historical observations, Pikeminnow occupy pools throughout the Russian River and the lower reaches of the larger tributaries.

Sacramento Pikeminnow prefer warm streams with abundant pools and cover.[259,260] Adults tend to be sedentary during daylight hours.[261] Juveniles (70 to 120 mm SL) were found in riffles and runs. Sacramento Pikeminnow prefer relatively low velocity habitat (<0.5 fps), except when foraging or moving from one pool to another, moderate depths (1.5 to 4.5 feet), and a substrate of gravel to boulder.[262]

Sacramento Pikeminnow prefer warm water compared to salmonids, are seldom abundant during non-winter seasons, where water temperature does not exceed 59.0˚ F,[263] and show a preference

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[258] Moyle, P.B. 2002. *Op. cit.*

[259] Taft, A. C. and G. I. Murphy. 1950. The life history of the Sacramento squawfish (*Ptychocheilus grandis*). California Fish and Game 36(2): 147-164.

[260] Moyle P. B. and R. D. Nichols. 1973. Ecology of some native and introduced fishes of the Sierra Nevada foothills in Central California. Copeia 3:478-490.

[261] Smith. J. J. 1982. Fishes of the Pajaro river System. Univ. Calif. Publ. Zool. 115: 85-169; cited in Brown L. R. 1990. Age, growth, feeding, and behavior of Sacramento squawfish (*Ptychocheilus grandis*) in Bear Creek, Colusa Co. California. The Southwest Naturalist 35(3):249-260.

[262] Knight, N. J. 1985). Microhabitats and tempearture requirements of hardhead (*Mylopharadon conocephalus*) and Sacramento squawfish (*Ptychocheilus grandis*), with notes for some other native California stream fishes. Ph.D. thesis. University of California, Davis: 161 pp.

[263] Moyle, P.B. 2002. *Op. cit.*

for a water temperature of 78.8˚ F.[264] The critical thermal maxima temperatures were 82.9˚ F for Sacramento Pikeminnow acclimated at 50.0˚ F, and 99.0˚ F when acclimated to 77.0˚ F.[265] Sacramento Pikeminnow tolerate low dissolved oxygen levels, and do not show a metabolic response to hypoxic conditions (dissolved oxygen levels at 25 percent of saturation for each temperature tested) at temperatures up to 77.0˚ F.[266]

Adults feed primarily at dawn, dusk and at night.[267] Sacramento Pikeminnow feed on aquatic insects as juveniles, switching to a diet primarily of fish as they grow.[268] Taft and Murphy (1950) examined the stomach contents of 36 juveniles (ranging in length from 3.3 to 17.8 cm FL) captured in the Russian River near Cloverdale. The diet of these fish consisted entirely of aquatic insects. Mertz and Vanicek (1996)[269] compared the diets of juvenile Sacramento Pikeminnow with steelhead and Chinook Salmon in the lower American River. They concluded that juveniles fed primarily on corixids (water boatmen) and chironomids (larval gnats), and that their diet did not overlap with either steelhead or Chinook Salmon. Buchanan et al. (1981) reported that 75 percent of the salmonids consumed were eaten by Northern Pikeminnow greater than 300 mm FL.

Adult Sacramento Pikeminnow are known to eat salmon and steelhead smolts.[270] Northern Pikeminnow can be a significant predator on juvenile salmonids below large dams when smolts become disoriented or injured while passing dams, and below hatcheries following large releases of smolts.[271] Buchanan et al. (1981) examined Northern Pikeminnow diets in free flowing sections of the Willamette River basin in Oregon. Although the fish in this study were collected during spring smolt emigration period, they fed primarily on insects, crayfish, and sculpin. Juvenile salmonids were found in 2 percent of the 1,127 Pikeminnow stomachs examined. Both Buchanan et al. (1980) and Thompson (1959,[272] cited in Brown and Moyle 1981)[273] found that Pikeminnow were opportunistic and fed on whatever prey source was most abundant. This may explain why they are such active predators of salmonids below dams and after hatchery releases.

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[264] Knight, 1985. *Op. cit.*

[265] Knight, 1985. *Op. cit.*

[266] Cech, et al. 1990. *Op. cit.*

[267] Brown, 1990. *Op cit.*

[268] Moyle, P.B. 2002. *Op. cit.*

[269] Merz, J. E. and D. Vanicek. 1996. Comparative feeding habitats of juvenile Chinook salmon, steelhead, and Sacramento squawfish in the lower American River, California. California Fish and Game 82(4): 149-159.

[270] Moyle, P.B. 2002. *Op. cit.*

[271] Shively R. S., T. P. Poe, and S. T. Sauter. 1996. Feeding response by northern squawfish to a hatchery release of juvenile salmonids in the Clearwater River, Idaho. Transactions of the American Fisheries Society 125:230-236.

[272] Thompson, R. B. 1959. Food of the squawfish Ptychocheilus oregonensis (Richardson) of the lower Columbia River. United States Fish and Wildlife Service, Fishery Bulletin 158:43-58.

[273] Brown L. R. and P. B. Moyle. 1981. The impact of squawfish on salmonid populations: a review. North American Journal of Fisheries Management 1:104-111.

In Central Valley streams, the presence of adult Pikeminnow can result in a shift in habitat used by other (prey) species.[274,275] Juvenile Rainbow Trout and Sacramento Suckers shifted to shallower, higher velocity (riffle) habitat, and Threespine Stickleback and juvenile California Roach shifted to near shore, shallow water habitat in the presence of Pikeminnow.[276]

In the Russian River, spawning takes place in April and May.[277] Eggs are adhesive and are attached to rocks or gravel. Pikeminnow inhabiting large rivers and reservoirs migrate into tributary streams to spawn during high flows.[278]

4.9.1.2 Smallmouth Bass

Smallmouth Bass are native to the eastern half of the United States and southern Canada.[279] Smallmouth Bass, first stocked in the Russian River in 1878,[280] are widespread throughout the mainstem.

Optimal water temperatures for growth range from 78.8 to 84.2˚ F, and preferred temperatures overall range from 70.0 to 80.5˚ F.[281] Growth is inhibited at temperatures below 50.0 to 57.2˚ F. Smallmouth Bass seek cover when temperatures drop to 59.0˚ F, and become inactive at approximately 50.0˚ F. Smallmouth Bass prefer DO levels in excess of 6.0 mg/l.[282]

Smallmouth Bass consume a wide variety of food items, including fish, crayfish, insects, and amphibians.[283] Juvenile salmonids can constitute a significant portion of their diet during the outmigration period.[284] Sub-yearling Chinook Salmon comprised 59 percent of the diet of Smallmouth Bass in one Columbia River study.[285] However, in another study, sub-yearling Chinook Salmon accounted for only 4 percent of Smallmouth Bass prey items.[286] Sub-yearling Chinook Salmon accounted for 12.4 to 25.8 percent of the diet of Smallmouth Bass collected in

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[274] Brown and Moyle 1991. *Op cit.*

[275] Brown L. R. and A. M. Brasher. 1995. Effect of predation by Sacramento squawfish (*Ptychocheilus grandis*) on habitat choice of California roach (*Lavinia symmetricus*) and rainbow trout (*Oncorhynchus mykiss*) in artificial streams. Canadian Journal of Fisheries and Aquatic Sciences. 52:1639-1646.

[276] Moyle P. B. and R. D. Nichols. 1973. Ecology of some native and introduced fishes of the Sierra Nevada foothills in Central California. Copeia 3:478-490.

[277] Taft and Murphy 1950. *Op cit.*

[278] Moyle, P.B. 2002. *Op. cit.*

[279] Moyle, P.B. 2002. *Op. cit.*

[280] Dill, W A, and A J Cordone. 1997. "History and status of introduced fishes in California, 1871-1996." Fish and Game Fish Bulletin 178.

[281] Edwards, E A., G. Gebhart, and O. E. Maughan. 1983. Habitat suitability information: smallmouth bass. U.S. Depart. Int., Fish and Wild. Serv. FWS/OBS-82/10.36. 47 pp.

[282] Edwards et al. 1983. *Op cit.*

[283] Moyle, P.B. 2002. *Op. cit.*

[284] Fayram, A H, and T H Sibley. 2000. "Impact of predation by smallmouth bass on sockeye salmon in Lake Washington, Washington." Norh American Journal of Fisheries Management 20: 81-89.

[285] Tabor, R. A., R. S. Shively, et al. 1993. Predation on juvenile salmonids by smallmouth bass and northern squawfish in the Columbia River near Richland, Washington. North American Journal of Fisheries Management 13: 831-838.

[286] Poe, T. P., H. C. Hansel, S. Vigg, D. E. Palmer, and A. Prendergast, 1991. Feeding of predaceous fishes on out-migrating juvenile salmonids in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120(4): 405-420.

three sections of the Columbia River during a seven- year study.[287] In another study, Smallmouth Bass consumed approximately 4 percent of the hatchery production in a given year. However, hatchery reared Chinook Salmon are larger than their wild counterparts, and predation on wild fish was likely higher.[288]

Smallmouth Bass are spring spawners, and spawning is generally initiated after water temperature increases to 55.0 to 59.9° F (range 39.9 to 70.0° F).[289] Preferred spawning substrate is gravel, but silt and sand can be utilized. Nests are generally built at depths between 0.3 to 0.9 m.[290] Spawning generally occurs in quiet backwater areas of streams.

4.9.2 Species of Uncertain Status

The Russian River fish community has expanded over time through natural and anthropogenic transfers. In addition, some members have been poorly studied, and their taxonomic designation is in question. Also, recent advances in genetic technology are restructuring the taxonomic relations of some species. As a result, a few species do not easily fit into pre-defined categories:

- Longfin Smelt have been detected in the Estuary near the mouth of the river during surveys conducted from 1997 through 2000, and in offshore habitat in 1971.[291] More recently, two larval Longfin Smelt were detected in January 2022; however, no detections were made associated with the same survey program in 2019 (22 tows) or 2020 (23 tows).[292] Longfin Smelt exhibits complex life history patterns, using a variety of habitats from nearshore waters, to estuaries and lower portions of freshwater streams. While consistent data collection efforts in the greater San Francisco Bay region provide much information regarding this species, less is known throughout its remaining range in California, including the Russian River Estuary. Additional discussion on status of Longfin Smelt is provided in Section 5.

- California roach in the Russian River are considered a sub-species by Moyle, et al. (2015), which they call the "Russian River roach." For the sake of ease, the commonly used "California roach" is used when referring to this species in this report.[293]

- Recent genetics work conducted by Baumsteiger (2013) has determined that the "riffle sculpin" in the Russian River is a separate, as, yet, undescribed, species.[294] Until the taxonomy of this species is updated, the name "riffle sculpin" will be used when referring to this species.

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[287] Zimmerman M. P. 1999. Food habits of smallmouth bass, walleyes, and northern pikeminnow in the lower Columbia River Basin during outmigration of juvenile anadromous salmonids. Transactions of the American Fisheries Society 128(6): 1036-1054.

[288] Fritts, A. L. and T. N. Pearsons. 2004. Smallmouth bass predation on hatchery and wild salmonids in the Yakima River, Washington. Transactions of the American Fisheries Society. 133:4. pp. 880-895.

[289] Emig, J. W. 1966. Smallmouth bass. In Inland Fisheries Management. A. Calhoun ed. Department of Fish and Game.

[290] Edwards et al. 1983. *Op cit.*

[291] Garwood RS. 2017. Historic and contemporary distribution of Longfin Smelt (*Spirinchus thaleichthys*) along the California coast. Eureka (CA): *California Fish and Game*;103(3):96– 117.

[292] Brennan, C., personal communications. Email coorespondence between Chris Fitzer, ESA, and Collin Brennan, ICF on October 5, 2022 regarding survey detection of Longfin Smelt in the Russian River Estuary.

[293] Moyle, P. B., R. M. Quinones, J. V. Katz, and J. Weaver. 2015. Fish species of special concern in California. California Department of Fish and Wildlife.

[294] Baumsteiger, J. D. 2013. Diversification, speciation, and phylogeography of freshwater sculpins (Cottus, Cottopsis) in California. Ph.D Thesis, University of Merced.

- The status of lampreys in the Russian River (family Petromyzontidae) is particularly complex. The “western brook lamprey” found in the Russian River (as well as other watersheds) is under taxonomic revision as a separate species. This species should be referred to as “Pacific brook lamprey” (*Lampetra* cf *pacifica*) until its taxonomy is completed. To further confuse this issue, true western brook lamprey that have been found in the East Fork Russian River are genetically identical to those in the Eel River. These lamprey are believed to have entered the Russian River through the PVP which connects the Eel River and Russian River watersheds. However, the current range of this species is outside of the action area. In addition, river lamprey were once thought to inhabit the Russian River; however, all such specimens collected to date are species other than river lamprey. Two species of lamprey are currently recognized as inhabiting the action area (Russian River Watershed downstream of Coyote Valley Dam): Pacific lamprey and Pacific brook lamprey. The distribution of western brook lamprey in the Russian River watershed is uncertain.

- Pink Salmon, are thought to be extirpated from the Russian River. However, seven adult Pink Salmon were observed at Sonoma Water’s Mirabel Dam Video Monitoring Station in 2002, along with eight adults in 2003 and one adult in 2011. These individuals are believed to be strays from other, more northern coastal rivers.

4.9.3 Russian River Watershed Historical Fish Monitoring

The Russian River fish community was surveyed on several occasions between 1897 and 1993.[295,296,297,298,299,300,301,302] These surveys have generally been conducted during the summer (July through August) period. Sampling techniques were generally limited to beach seining and a fish toxicant (Rotenone). Beach seining is biased towards capturing smaller individuals, and its effectiveness is highest in shallow habitats that have smooth, unobstructed substrates, with moderate slopes.

During historical surveys, native resident fish (Sacramento suckers and Sacramento Pikeminnow), introduced bass and sunfish (Smallmouth Bass and Green Sunfish), and juvenile American Shad dominated the catch. Pintler and Johnson (1956) provide anecdotal information on the distribution and relative abundance of several species of fish collected after the application of Rotenone to the Russian River. In the 1950’s, CDFW conducted an experiment to determine if steelhead populations could be increased by reducing populations of non-salmonids. The hypothesis was that non-salmonids competed with and/or preyed on steelhead. The perceived

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[295] Snyder, J.O. 1907. *Op. cit.*

[296] Johnson, W.C. 1954. A fisheries survey of the Russian River from Mirabel Park to Jenner. Memorandum to W.A. Evans, California Department of Fish and Game.

[297] Johnson, W.C. 1955. Survey of the lower Russian River fish population. Memorandum to C.K. Fisher, California Department of Fish and Game.

[298] Pintler, H.E., and W.A. Johnson. 1956. Chemical control of rough fish in the Russian River drainage, California. Inland Fisheries Administrative Report No. 56-13, California Department of Fish and Game.

[299] Johnson, W.C. 1957. A progress report on the Russian River fish population study: 1954-1956. Inland Fisheries Administrative Report No 57-16, California Department of Fish and Game.

[300] Hopkirk, J.D., and P.T. Northen. 1980. Technical report on fisheries of the Russian River: Part of the Aggregate Resources Management Study conducted by the County of Sonoma. Submitted to the Sonoma County Planning Department.

[301] Cox, B. 1984. Russian River fish population survey. Memorandum, Department of Fish and Game.

[302] Goodwin, P, C K Cuffe, J L Nielsen, and T Light. 1993. Russian River Estuary study. Prepared for Department of Planning, Sonoma County and California State Coastal Conservancy.

competition and predation by these species was thought to be reducing the steelhead population; therefore, by reducing the numbers of non-salmonids in the Russian River watershed, steelhead populations would respond by increasing in abundance. Although the steelhead population showed an initial positive response to the removal of non-salmonids, the increases were short lived, the non-salmonid populations quickly recovered, and the program was abandoned. According to Pintler and Johnson (1956), Sacramento suckers were the most abundant species collected, and were noted as being very abundant throughout the river. Juvenile Lamprey and Tule Perch were also noted as abundant throughout the river. Sacramento Pikeminnow and Hardhead were found in low numbers. Smallmouth Bass comprised 0.5 percent of the fish collected. Juvenile steelhead were collected in low numbers throughout the Russian River.

Summertime water temperatures are believed to limit steelhead habitat in the lower Russian River. During a 1954 study, four juvenile steelhead were captured at one site below Northwood (water temperature 75.0° F), ranging in length from 4 to 7 inches. All steelhead captured were infected with external parasites. Three additional steelhead were captured below Austin Creek. No juvenile steelhead were observed or captured during a 1984 CDFW study. However, in 1955, 153 juvenile steelhead YOY were captured in the lower Russian River at 30 sampling stations (generally one beach seine haul per site).

Based on fish assemblage data from the early 1950's, Dry Creek downstream of the present Warm Springs Dam was a moderately warm stream that was intermittent to dry in its lower reaches.[303] According to Pintler and Johnson (1956), the fish assemblage was dominated by California Roach, Sacramento Sucker, Sacramento Pikeminnow and Tule Perch. Juvenile steelhead were reported to be locally abundant, but scarce overall.

4.9.4 Russian River Watershed Current Fish Monitoring

4.9.4.1 Sonoma Water Monitoring History

Sonoma Water has been monitoring salmon and steelhead populations in the Russian River Watershed since 1999 (see https://www.sonomawater.org/reports for monitoring reports) and CSG has been monitoring salmon and steelhead populations since 2004 (see https://caseagrant.ucsd.edu/project/russian-river-salmon-and-steelhead-monitoring-program for monitoring reports). Prior to 2008, Sonoma Water's monitoring efforts were mainly focused on the Russian River mainstem and Estuary while CSG's efforts were mainly focused on Coho Salmon bearing tributaries to the Russian River. Sonoma Water's monitoring elements included video monitoring of adult upstream migrants, downstream migrant trapping, beach seining in the Estuary, juvenile snorkel and adult spawner surveys, water quality monitoring, invertebrate sampling, and habitat surveys. Several of CSG's monitoring methods and approaches are similar, but instead they have focused on evaluating the Coho Broodstock Program. Collectively, these monitoring programs are foundational to the monitoring activities outlined in the *2008 Biological Opinion*.

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[303] Pintler, H.E., and W.A. Johnson. 1956. *Op. cit.*

4.9.4.2 Biological Opinion Monitoring

Much of Sonoma Water's and CSG's historical monitoring were incorporated into the *2008 Biological Opinion,* as well as several new monitoring elements, that guide Sonoma Water and the USACE to provide additional data to evaluate Project impacts. These monitoring elements are described in the Project Modifications and New Project Elements of the Reasonable and Prudent Alternative (RPA). Most elements included details for evaluating Project impacts in the Russian River Estuary, Dry Creek, and other locations in the watershed. In the following sections, the RPA elements that necessitate monitoring are summarized to describe the type of monitoring conducted and how that monitoring relates to each RPA included in the *2008 Biological Opinion*. These monitoring actions are also summarized within **Table 4-33**.

RPA Element 1. Pursue Changes to Decision 1610 Flows

Although there is no biological monitoring described for this RPA element in the *2008 Biological Opinion*, Sonoma Water has been conducting monitoring under various TUCOs that inform impacts of changes in flow relative to SWRCB Decision 1610. These monitoring efforts are described above under Section 3.3.1.1, *Temporary Urgency Change Orders.*

RPA Element 2. Alterations to Estuary Management

To meet the objective of RPA element 2 for alterations to estuary management, Sonoma Water implemented an Adaptive Management Plan that is updated annually by Sonoma Water in collaboration with NMFS, CDFW and California State Parks (CSP).[304] A timeline of plan revisions, along with a description of the coordination process between Sonoma Water and agency staff, is contained within the Chapter 1 of each version of the plan. The Adaptive Management Plan is intended to meet the RPA objectives to minimize flood risk and enhance rearing habitat for juvenile steelhead by tailoring beach management actions to conditions at the time of the action, monitoring to assess beach and Estuary responses, evaluate physical processes impacting estuarine conditions from year to year, and includes annual review and revision of the plan, which is discussed in greater detail in Section 4.4.5, *Russian River Estuary*.

This RPA element includes several monitoring activities designed to evaluate how physical and biological processes are affected by changes to estuary management (**Table 4-34**). Physical monitoring is focused on evaluating how changes in management actions that control estuarine water levels influence water quality, beach morphology, and hydrology. Biological monitoring is focused on evaluating rearing habitat conditions during the lagoon management season, seasonal use of the Estuary by juvenile salmonids, and their response to changed habitat conditions that result from changes in management actions.

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[304] Environmental Science Associates (ESA) & Bodega Marine Laboratory, 2023. Russian River Estuary Adaptive Beach Management Plan. Prepared for Sonoma Water. May 15, 2023.

TABLE 4-33
SUMMARY OF MONITORING ACTIONS FROM 2008 BIOLOGICAL OPINION RPA

2008 Biological Opinion RPA Element	Target Species and Life Stage	Objectives	Method	Locations	Responsible Organization	Document Reference (for results)
RPA 2. Alterations to Estuary management	steelhead juveniles	timing, relative abundance, size, and age structure at Estuary entry	DSMT	lower river tributaries defined as downstream of Mirabel Dam	Sonoma Water	see Section 4.3.7.10, *Biological Monitoring*
			PIT antenna	Estuary	Sonoma Water	
		fish habitat use, physical habitat characteristics	seine, PIT antennas, habitat monitoring	Estuary	Sonoma Water	
		water quality	sondes	Estuary	Sonoma Water	see Section 4.3.7.8, *Water Quality Monitoring*
		physical process	camera, topographic surveys	river mouth	Sonoma Water	see Section 4.3.7.6, *Beach Management*
RPA 3. Dry Creek Habitat Enhancements	Coho Salmon and steelhead juveniles	implementation	see AMP checklists	Dry Creek	Sonoma Water	see Section 4.4.4.2, *Dry Creek Habitat Enhancement*
		Effectiveness (1°): velocity, depth, shelter value, pool/riffle ratio	habitat mapping	Dry Creek	Sonoma Water	see Section 4.4.4.2, *Effectiveness Monitoring*
		Effectiveness (2°): water quality	water quality	Dry Creek	Sonoma Water	
		Validation (1°): habitat use	PIT antenna, snorkel	Dry Creek	Sonoma Water	see Section 4.4.4.2, *Validation Monitoring*
		Validation (1°): abundance/density	electrofish, seine	Dry Creek	Sonoma Water	
		Validation (1°): relative abundance	DSMT	Dry Creek	Sonoma Water	
		Validation (2°): fidelity, growth/size, survival	PIT antenna, electrofish, seine	Dry Creek	Sonoma Water	
RPA 4.Coho Salmon Broodstock Program Enhancements	Coho Salmon (all life stages)	genetic monitoring	various	Warm Springs Hatchery	USACE	See Section 5.5.2, *Coho Salmon*
	Coho Salmon juveniles, smolts, adults	effectiveness and performance of population once fish are released into the wild	DSMT, snorkel surveys, PIT antennas, spawner surveys	Mill, Green Valley, Dutch Bill, Willow Creeks	USACE	

TABLE 4-33 (CONTINUED)
SUMMARY OF MONITORING ACTIONS FROM 2008 BIOLOGICAL OPINION RPA

2008 Biological Opinion RPA Element	Target Species and Life Stage	Objectives	Method	Locations	Responsible Organization	Document Reference (for results)
RPA 5. Annual Monitoring of Salmonid Migration in the Russian River at Mirabel/Wohler and Dry Creek	Coho and Chinook salmon and steelhead juveniles	juvenile outmigration	DSMT	Russian River (Mirabel Dam), Dry Creek	Sonoma Water	See Sections 5.5.1.1, *Adults* and 5.5.2.1 *Adults*
	Chinook Salmon adults	adult return estimation	video	Russian River (Mirabel Dam)	Sonoma Water	See Section 5.5.3.1, *Adults*

TABLE 4-34
MONITORING PURPOSE, ACTIVITY, AND YEARS CONDUCTED FOR RPA ELEMENT 2: ALTERATIONS TO ESTUARY MANAGEMENT

Purpose	Activity	Years Conducted
Beach Morphology	Topographic Surveys	2010-present[a]
	Remote Camera (River Mouth)	2010-present
Water Quality	Continuous Sonde (Multi-parameter YSI)	2009-present[b]
Estuary Productivity	Invertebrate Sampling	2010-2019
	Steelhead Diet Sampling	2009-2019
Juvenile steelhead	PIT Tagging and PIT Antenna Operation[c,d]	2010-present
	Estuary Seining	2008-present
	Downstream Migrant Trapping (DSMT)	2009-present

NOTES:

a Conducted monthly
b Deployed during May 15 – October 15 lagoon management season
c Initially implemented as fyke monitoring in upper Estuary, which occurred in 2009-2012
d Austin Creek antenna operation began in 2010 and Duncans Mills antenna operation begin in 2013

SOURCE: SCWA, 2022. G. Horton and A. Pecharich personal communication. March 10, 2022.

The intent of beach topographic surveys and the operation of a remote camera is to help determine the potential for flooding, analyze effects of sediment transport on beach morphology, and inform beach management decisions. Information obtained through this monitoring is evaluated and incorporated into the development of annual adaptive management plans and utilized in monitoring changing conditions that influence potential for formation of the barrier beach and subsequent closures of the river inlet.

Sonoma Water began monitoring Estuary water quality as early as 1996[305] and implementation of the *2008 Biological Opinion* expanded these earlier efforts. The intent of water quality sampling required by the RPA is to monitor water temperature, salinity, dissolved oxygen, and pH and to evaluate how these parameters change in response to adaptive estuary management. Although not included as part of monitoring described for this element, weekly and event-based water grab samples for nutrient and pathogen testing, and algae are also collected as described in the project's Water Quality Monitoring Plan required by permits from state agencies. A summary of water quality monitoring is provided in Section 4.6, *Water Quality*.

The intent of invertebrate sampling for this element is to determine the spatiotemporal distribution, composition (species richness and diversity), and relative abundance of potential prey items for juvenile salmonids in the Estuary. Benthic infauna, epibenthos, and zooplankton sampled in the lower, middle, and upper portions of the Estuary allow evaluations of invertebrate community response to changes in inflow, water circulation patterns (stratification), and water quality resulting from alterations in sandbar management. Companion data on gut contents from gastric lavage sampling of live juvenile steelhead have also informed understanding of prey selection, bioenergetic models, and habitat selection.[306,307,308]

The intent of salmonid monitoring for this element is to provide information on timing of downstream movements of juvenile steelhead into the Estuary, and distribution, relative abundance, residence time, and habitat characteristics from early summer to late fall. The methods for accomplishing this include PIT-tagging juvenile steelhead at downstream migrant traps in lower basin locations (i.e., downstream of Dry Creek), operating a PIT antenna array near the upstream end of the Estuary, and beach seining throughout the Estuary. Note that although this element originally called for operating a fyke net in the upper Estuary, because of operational difficulties (and after consulting with NMFS and CDFW), the fyke net was abandoned in favor of installation and operation of a PIT antenna array in the upper Estuary (Duncans Mills, rkm 10.5). Between 2009 and 2021, Sonoma Water PIT-tagged nearly 12,000 juvenile steelhead at lower basin traps with nearly 73 percent tagged at the Austin Creek trap.

Sonoma Water has been monitoring juvenile outmigration at the Mirabel Dam (see RPA Element 5 below) and three tributaries downstream of the Mirabel Dam for several years (**Table 4-35**).

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[305] Merrit Smith Consulting, 1997. Biological and water quality monitoring in the Russian River Estuary, 1996 report. Prepared for Sonoma Water. February 21, 1997.

[306] Seghesio, E. E. 2011. *Op. cit.*

[307] Matsubu, W. C. 2019. Tradeoffs of juvenile steelhead (*Oncorhynchus mykiss*) rearing in an intermittently closed estuary, northern California USA. Ph.D. dissertation, School Aquat. Fish. Sci., Univ. Washington, Seattle, WA. 226 pp.

[308] Boughton, D., J. Fuller, G. Horton, E. Larson, W. Matsubu, and C. Simenstad. 2017. *Op. cit.*

One of the main purposes of these efforts is to inform the timing of downstream movements, relative abundance, and the size and age structure of steelhead YOY by providing a source of PIT-tagged individuals that could be detected at the Duncans Mills PIT antenna array should they move into the Estuary (**Figure 4-30**).

TABLE 4-35
STREAMS, SITES, YEARS OF SONOMA WATER DOWNSTREAM MIGRANT TRAP OPERATION, AND DISTANCE OF THE TRAP SITE FROM THE MOUTH OF EACH STREAM

Stream	Site	River Kilometer	Years Operated	Additional Objectives
Russian River	Mirabel Dam	39.6	2000-present[a]	Coho Salmon outmigrant characterization; Chinook Salmon smolt estimates in some years
Mark West Creek	Trenton-Healdsburg Road	4.7	2012-present	Coho Salmon life cycle monitoring
Dutch Bill Creek	Monte Rio Park	0.3	2010-present	Coho Salmon life cycle monitoring
Austin Creek	Gravel Mine	1.1	2010-present	relative abundance of Coho Salmon smolts

NOTES:

[a] Not operated in 2015 and 2016 because of fish screen replacement and new fish ladder construction.

SOURCE: Sonoma Water, 2022. G. Horton and A. Pecharich personal communication. March 10, 2022.

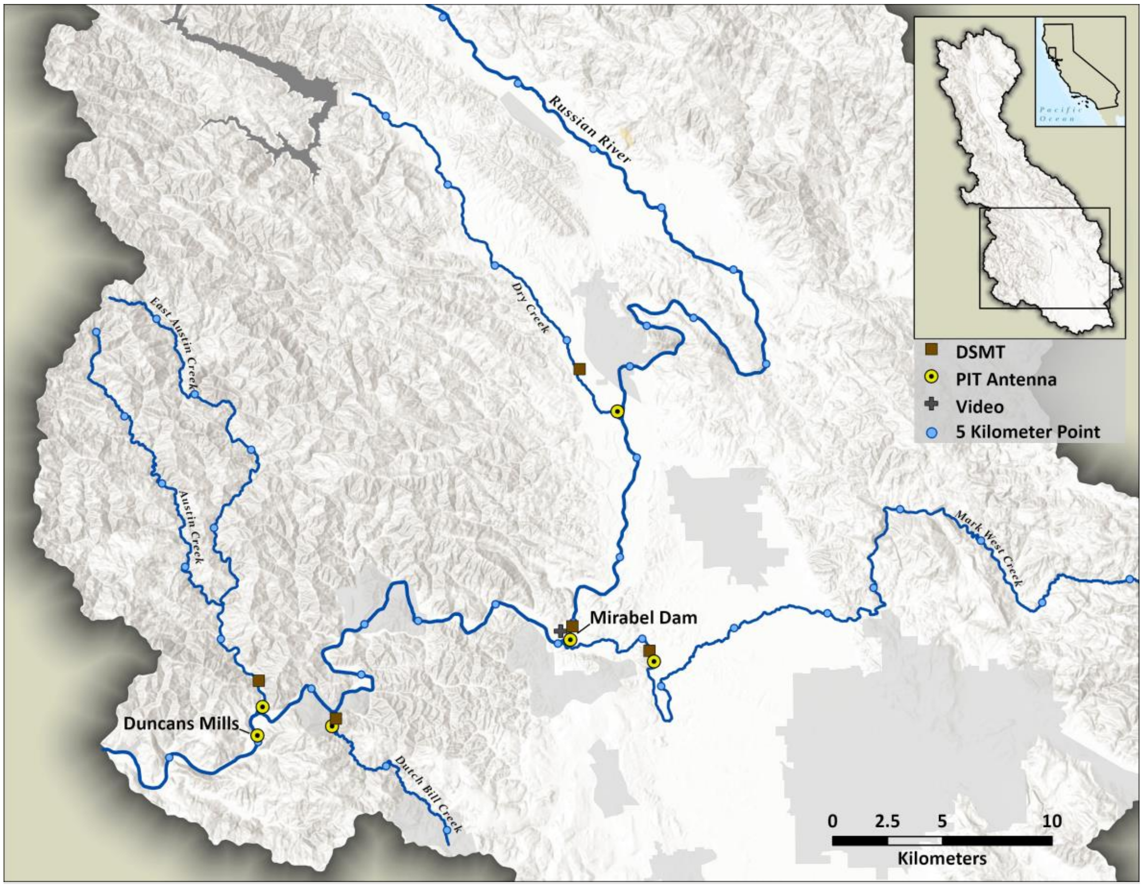

Figure 4-30
Spatial extent of fish monitoring stations

Since 2003, beach seining has been conducted throughout the Estuary from mid-May through mid-October with the main objective of obtaining relative fish abundance and geographic distribution of juvenile steelhead residing in the Estuary. The primary metric for fish abundance is mean catch-per-unit-effort (CPUE) defined as the number of juvenile steelhead captured per seine net haul. Sampling methods and approach followed the RPA except for: 1) a reduction in sampling frequency in 2013 (approved by NMFS and CDFW) during the lagoon management season (May 15 to October 15); and 2) no sampling in the 2020 season due to the COVID-19 pandemic. Fish captured during seining samples coupled with vertical water quality profiles are used to characterize habitat occupied by juvenile steelhead and capture of PIT-tagged juveniles allows calculation of individual-based growth rates in the Estuary. Between 2009 and 2022, an average of 198 seine sets per year were used to calculate CPUE.

RPA Element 3. Dry Creek Habitat Enhancements

The RPA element includes enhancement of Coho Salmon and steelhead rearing habitat in lower Dry Creek and its tributaries. Habitat enhancement in Dry Creek focuses on providing rearing habitat during the low flow (summer) and high flow (winter) seasons by creating pool-riffle habitat and velocity refuges for juvenile Coho Salmon and steelhead. Tributary enhancement is focused on providing rearing habitat for salmonids in tributaries that enter Dry Creek downstream of Warm Springs Dam. A summary of the completed tributary enhancement projects is provided in Section 4.5.3.1, *Completed Enhancement Projects*.

The RPA describes how habitat enhancement projects in Dry Creek would create winter and summer rearing habitats for both juvenile steelhead and Coho Salmon, with an emphasis on improving habitats for the survival of juvenile Coho Salmon. The RPA includes a timeline for conceptual design, planning, project review, permitting, pre-construction monitoring, construction, post-construction monitoring, project evaluation, and adaptive management. The RPA also states that a plan for physical and biological monitoring protocols would be developed. In 2014 an Adaptive Management Plan (AMP)[309] was developed in partnership with Sonoma Water, USACE, NMFS, CDFW, Inter-Fluve, and ESSA Technologies to guide the evaluation of these habitat enhancement projects. This RPA element and the AMP are discussed in detail in Section 3.9.2.2, *Adaptive Management.*

RPA Element 4. Coho Broodstock Program Enhancements

The RPA includes annual genetic analyses for all broodstock that are part of the Coho Broodstock Program, that will result in an annual spawning matrix designed to avoid mating closely related individuals during the hatchery spawning process. Additionally, naturally spawned and hatchery reared components of the Russian River Coho Salmon population are continually evaluated to detect signs that the population is showing signs of inbreeding. Both measures have been ongoing throughout implementation of the *2008 Biological Opinion*. In the past several years, certain genetic indicators have suggested the prudence of incorporating parents from nearby Coho populations in Lagunitas and Olema Creeks.

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[309] Porter, M., D. Marmorek, D. Pickard, and K. Wieckowski, 2014. *Op. cit.*

This RPA also lists monitoring and evaluation of the Coho Broodstock Program to evaluate the effectiveness and performance of the population once fish are released into the wild. This monitoring is conducted through an agreement between the USACE and CSG and it consists of monitoring to:

- Estimate juvenile survival from release to the smolt stage
- Develop expanded counts of hatchery-origin adults
- Evaluate natural spawning success
- Assess trends in abundance of naturally produced Coho Salmon

Monitoring activities are conducted in four streams that are central to the Coho Broodstock Program (Mill, Green Valley, Dutch Bill, and Willow Creeks).[310] Since the first Coho releases, university, local, state, and federal biologists have been using data collected from this effort to adaptively manage future releases. This has resulted in more emphasis on releases of age-0+ fish in the fall and age-1+ smolts in the spring with less emphasis on releases of age-0+ fish in the spring. Monitoring data along with attention to streamflow conditions has also become an important consideration during the development of annual release plans.

RPA Element 5. Annual Monitoring of Salmonid Migration in the Russian River at Mirabel/Wohler and Dry Creek

The RPA states that information from juvenile outmigration and adult escapement monitoring at the Mirabel Dam, and juvenile outmigration in lower Dry Creek provides important information for efforts to recover steelhead, Chinook Salmon, and Coho Salmon in north-central California. Sonoma Water has been operating the Mirabel downstream migrant trap and video monitoring targeting adult Chinook escapement upstream of the Mirabel dam each season since 2000. Exceptions were during construction to replace the fish screens and construct a new fish ladder which precluded trap operation at that site in 2015 and 2016 and video monitoring in 2014 and 2015. The Dry Creek downstream migrant trap has been operated each season since 2009.

The RPA element also states that monitoring juvenile Coho and steelhead abundance at multiple sites in Dry Creek will provide important support for efforts to recover listed salmonids. Additionally, this monitoring provides an important spatial and temporal context in which to interpret the validation monitoring results for habitat enhancement in Dry Creek (RPA element 3). Electrofishing surveys in the main channel of Dry Creek have been implemented since 2008. These surveys are used to estimate population density of juvenile steelhead, and detect the presence of Coho juveniles, in multiple reaches of the lower 23 km of Dry Creek annually. Summary results of these surveys are presented in Section 5.

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[310] California Sea Grant (CSG), 2021. Monitoring and evaluation of Russian River Coho Salmon: Detailed research plan for contract W912P721C0002. Windsor, California.

4.9.4.3 Related Monitoring

Abundance and Survival

Although not specifically described in the RPA or RPMs of the *2008 Biological Opinion*, stationary PIT antenna arrays have become a critical part of the Russian River monitoring program for multiple life stages in multiple seasons and have served to at least partially satisfy RPA elements 2, 3, 4, and 5. PIT tagging and PIT antennas allow estimation and evaluation of Estuary entry by juveniles, habitat enhancement utilization by juveniles, juvenile over-summer and over-winter survival, abundance of steelhead smolts, smolt migration survival, and adult abundance and migration timing.

By using the known or estimated proportion of tagged individuals in the population at time 1 in conjunction with detections from stationary PIT antenna arrays upstream of a given site (for adults) or downstream of a given site (for smolts), antenna efficiency can be estimated and used as a factor to adjust minimum counts to expanded counts. These expanded counts thus represent abundance for a population interest passing a given site. Because of the location of the Duncans Mills antenna array near the upstream end of the Estuary, expanded counts of adult Coho at that site represent adult returns of PIT-tagged fish to the basin (except for a few small tributaries downstream of Duncans Mills: Willow, Sheephouse, and Freezeout Creeks). By further expanding that count to the entire population based on the known fraction of PIT-tagged fish leaving as smolts, that estimate can be further expanded to include adult returns for the entire hatchery portion of the population. In tributary streams (Mill, Mark West, Dutch Bill, Green Valley, and Willow Creeks), PIT antennas operated in conjunction with downstream migrant traps in a mark-recapture framework provide a means to generate annual estimates of overwinter survival of Coho from the parr to smolt stage.

The peak of steelhead smolt outmigration occurs prior to the period when stream flows have decreased from winter levels and downstream migrant traps can be safely installed and operated. Because of this, downstream migrant trapping alone has not been useful in estimating the population size of steelhead smolts at any of the traps operated by Sonoma Water or CSG, including Dry Creek. The combined efforts of calculating a pre-smolt estimate of juvenile steelhead abundance and marking a known fraction with PIT tags that are then subject to detection at downstream antenna arrays provides a method to estimate steelhead smolt abundance (See Section 5.5.1.3, *Smolts*). This would, in turn, provide an important basis needed to generate estimates of survival from the parr to smolt stage and from the smolt to adult stage.

Smolt Migration Survival

In past years, Sonoma Water piloted a project to evaluate the possibility of using PIT-tagged fish to estimate smolt survival as they make their way downstream. Chinook Salmon smolts were captured at the Dry Creek trap, PIT-tagged, and released allowing them to continue their downstream migration. PIT-tag survivors were then subject to detection approximately 12 km downstream at the Mirabel Dam PIT antenna or downstream migrant trap. Similar data are also available for PIT-tagged Coho Salmon smolts.

In spring 2021 and 2022, Sonoma Water, USACE, and CSG also piloted a project using acoustic telemetry to evaluate Coho smolt survival through the mainstem Russian River and Estuary.[311] Preliminary data from both the PIT- and acoustic-tagging projects offer promise for identifying potential survival bottlenecks as smolts migrate downstream. A summary of the Coho Salmon acoustic telemetry study is provided below.

Coho Salmon Smolt Survival Studies (Acoustic Telemetry)

In 2021 and 2022 Sonoma Water conducted survival studies focused on Coho Salmon smolts. The goal of these studies was to provide information on the efficacy of recovery strategies based on releases of hatchery-reared Coho Salmon smolts. The primary study objective was to estimate Coho Salmon smolt survival from Dry Creek through the mainstem Russian River and Estuary – the “migration corridor.” A secondary objective was to evaluate methods for characterizing sources of mortality.

In 2021, two releases of fish tagged with acoustic transmitters were conducted at one-week intervals from late April through early May. In 2022, four releases of fish tagged with acoustic transmitters were conducted at one-week intervals from mid-April through mid-May. Fish were released below WSD and tracked (via hydrophone detections) down Dry Creek into the mainstem Russian River down to the Estuary (see study reach breaks depicted on **Figure 4-31**).

Survival estimates were developed for the entire study area (all reach breaks) by release group (date) (**Figure 4-32**) and by river segment (Dry Creek, Russian River mainstem, Estuary) (**Figure 4-33**). Trends in survival were identified by release group with survival decreasing from first to last release. Further, Dry Creek and the Estuary were identified as segments with higher survival compared to the mainstem Russian River.

Reach-specific survival estimates and estimated loss rates were developed for the 2022 releases with marked decreases in survival identified for the reach at the Dry Creek mouth (from the mouth to Syar ponds) and at the Mirabel Dam (see **Figure 4-34** and **Figure 4-35**). Highest estimates of mortality (or loss) were identified for the later (May) release groups.

Additional analysis of environmental factors (flow, turbidity, and temperature) was also conducted to identify potential relationships between these factors and survival. Survival estimates as a function of flow are shown in **Figures 4-36** and **4-37**. Survival estimates as a function of turbidity are presented in **Figure 4-38** and **Figure 4-39**. The analysis found positive relationships between higher survival and higher flow, higher survival and higher turbidity.

Water temperature conditions for Dry Creek (near the mouth) and Russian River mainstem (near Syar Road) are presented in **Figure 4-40**. The analysis found relatively abrupt changes (up to 2-3 degrees Celsius) in water temperatures transitioning between Dry Creek and the Russian River mainstem, a reach where survival was estimated as being lower.

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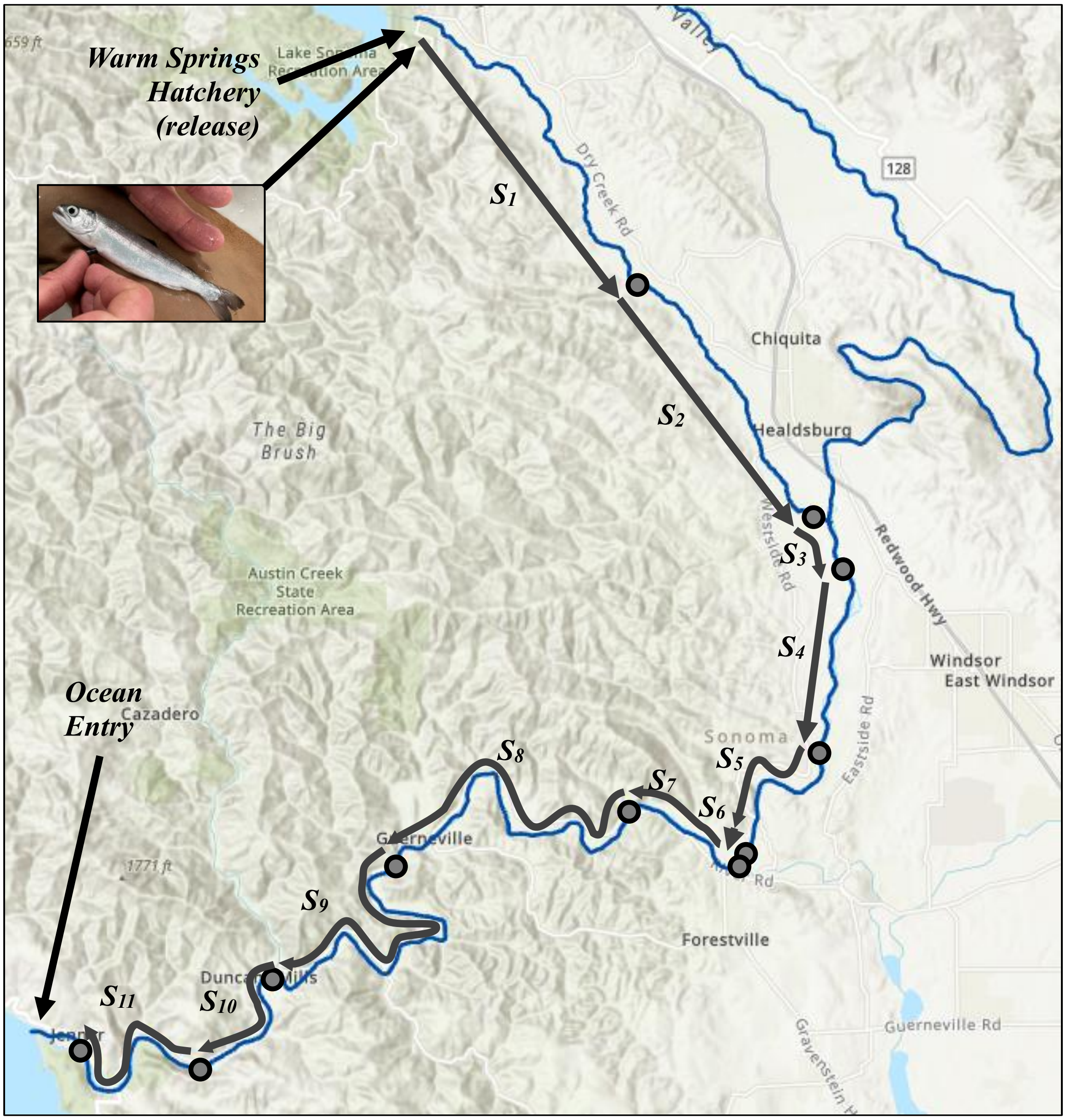
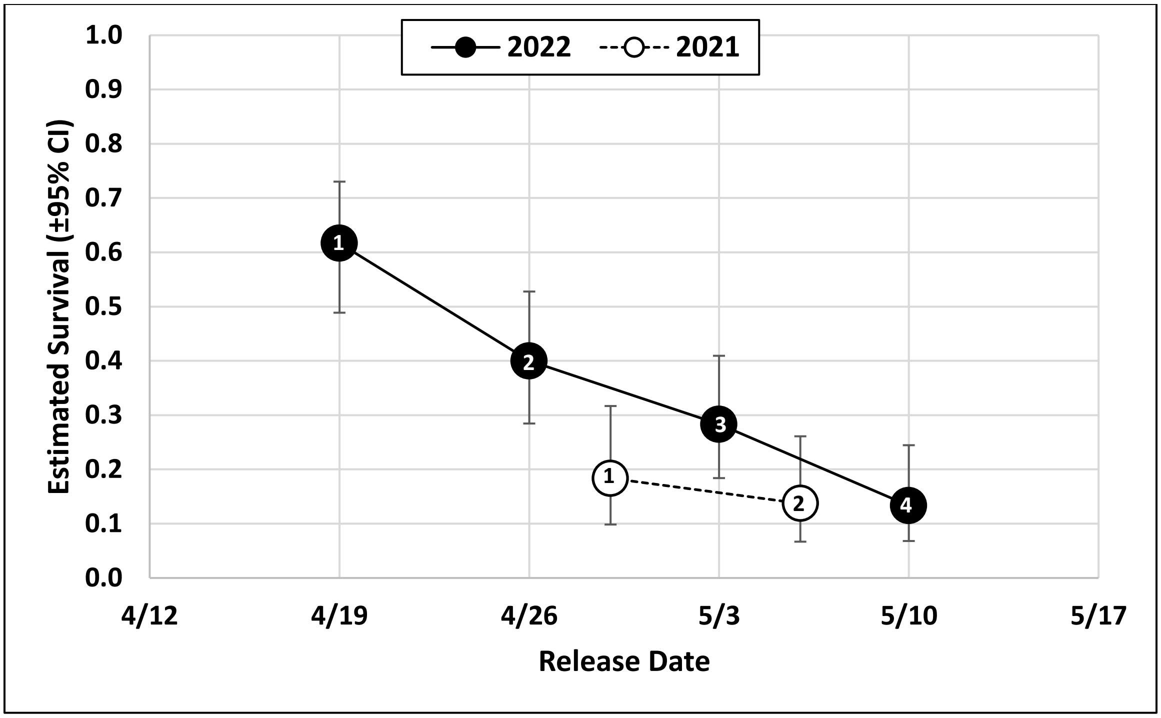
[311] Horton, G.E., E. McDermott, M. Obedzinski. 2021. 2021 Progress Report: Using acoustic telemetry to estimate reach specific riverine and estuarine salmonid survival in the Russian River watershed. Sonoma County Water Agency, Santa Rosa, CA. 12 pages.



Note: Shaded points represent acoustic gate.

Figure 4-31
Coho Salmon smolt survival study, 2022



Note: Numbers on data points represent release group number for each year.

Figure 4-32
Overall survival from release in Dry Creek to near the downstream end of the Russian River Estuary (rkm 2.25)

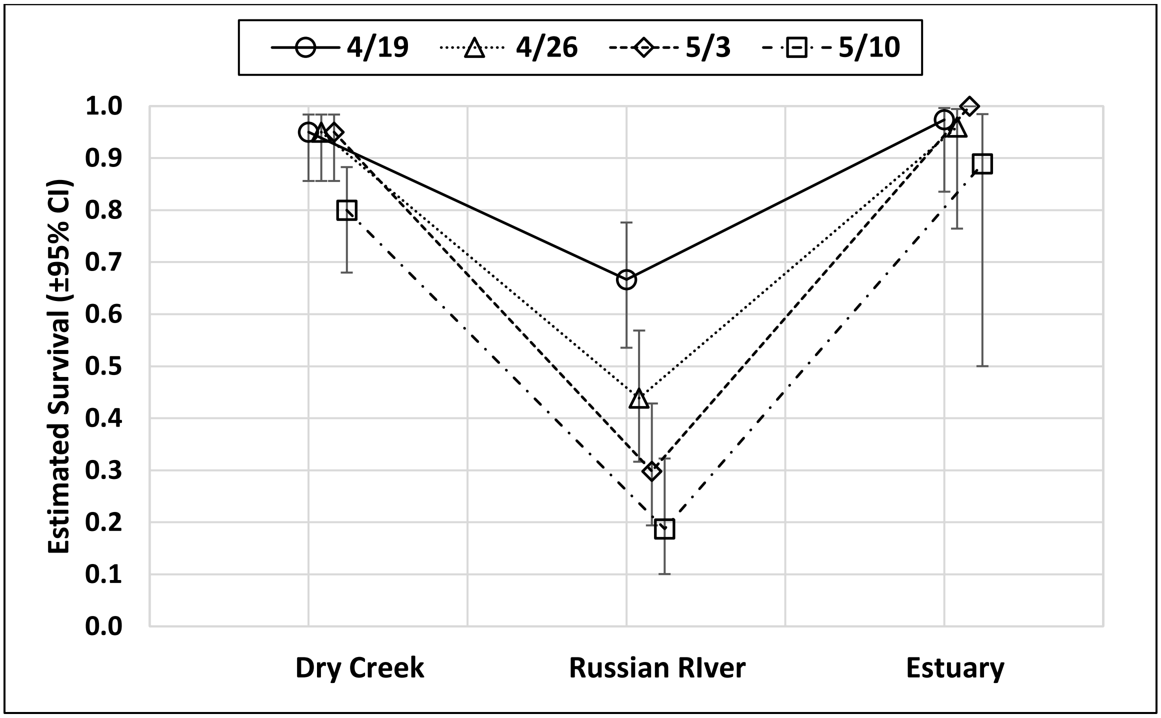


Figure 4-33
Tributary-specific survival for each release group, 2022

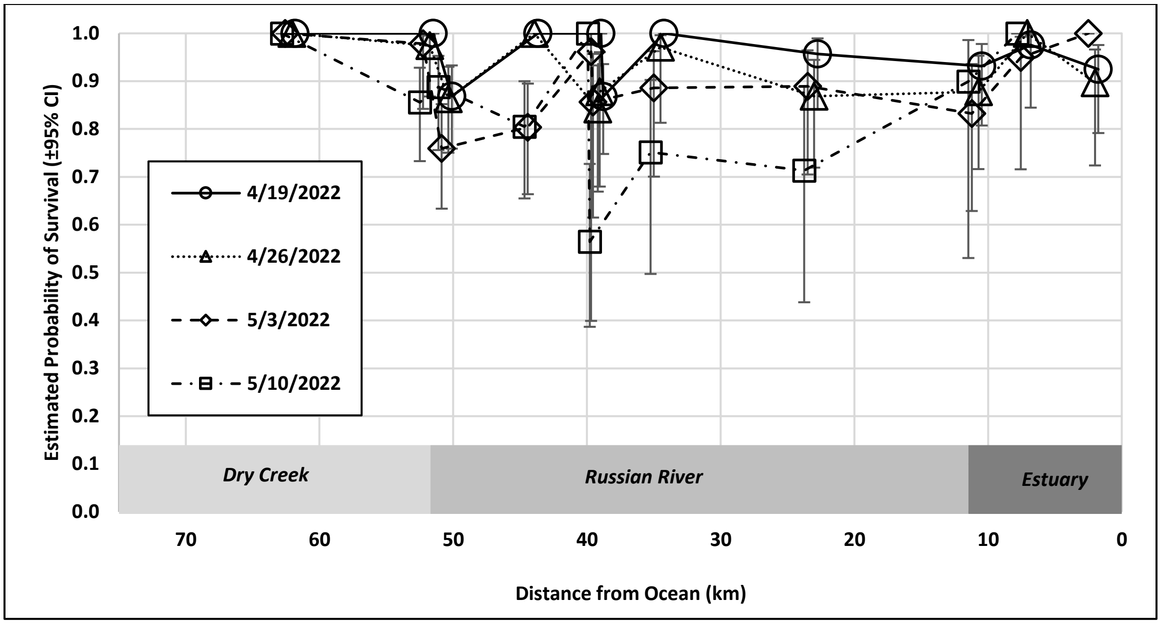


Figure 4-34
Estimated probability of reach specific survival along smolt migration corridor, 2022

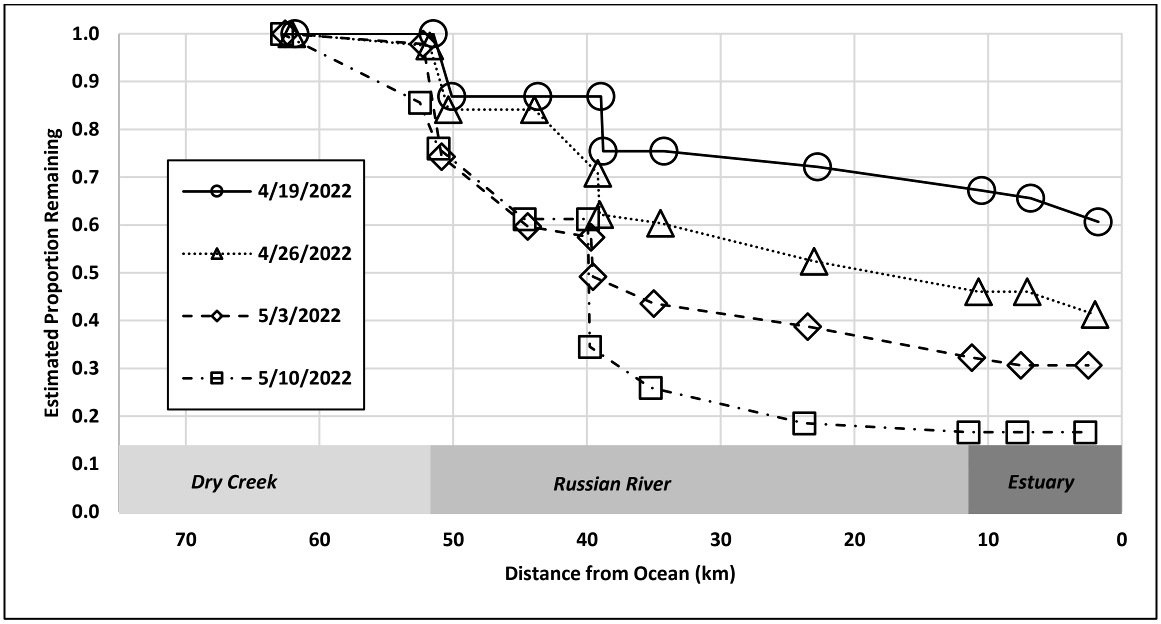


Figure 4-35
Estimated cumulative reach-specific loss along smolt migration corridor, 2022

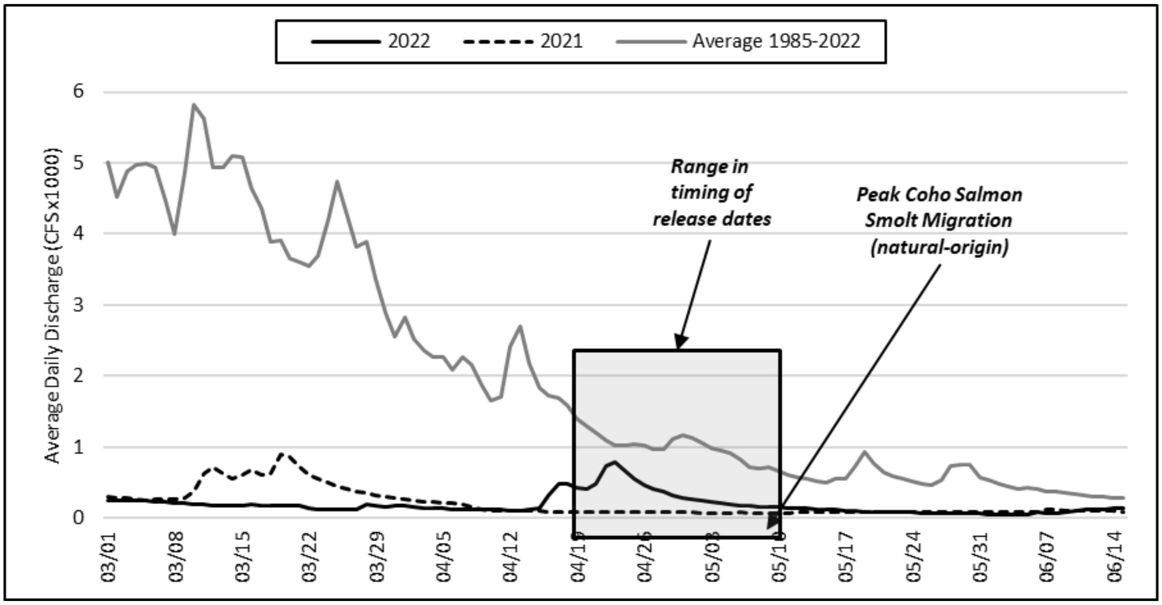


Figure 4-36
Stream discharge in the mainstem Russian River (Hacienda USGS Gauge)

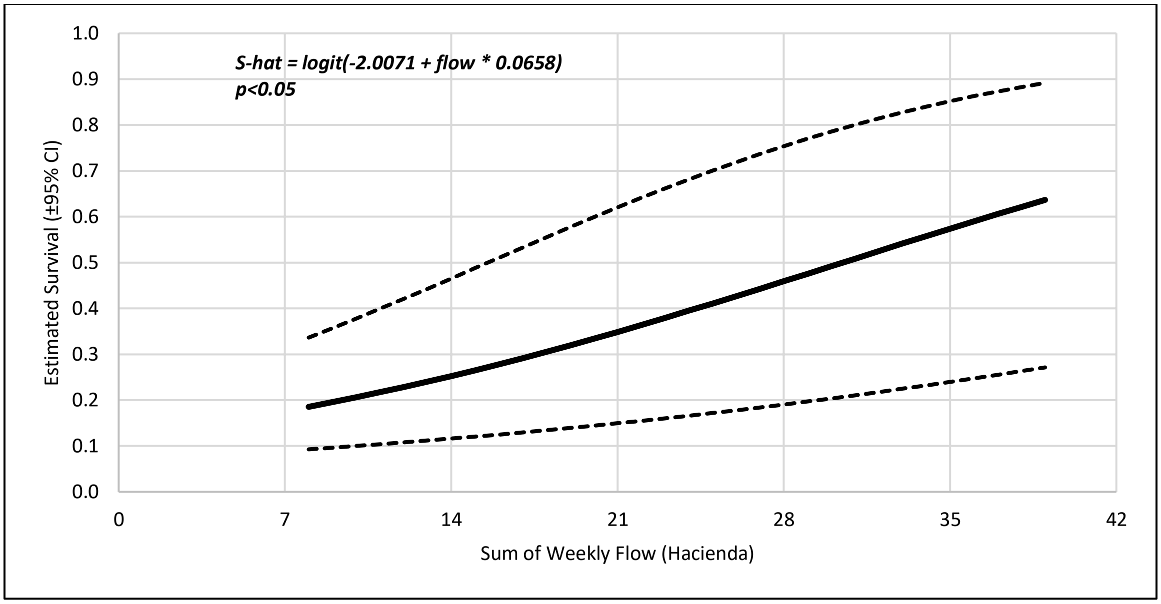


Figure 4-37
Estimated survival as a function of summed weekly discharge in the mainsteam Russian River (Hacienda USGS Gauge)

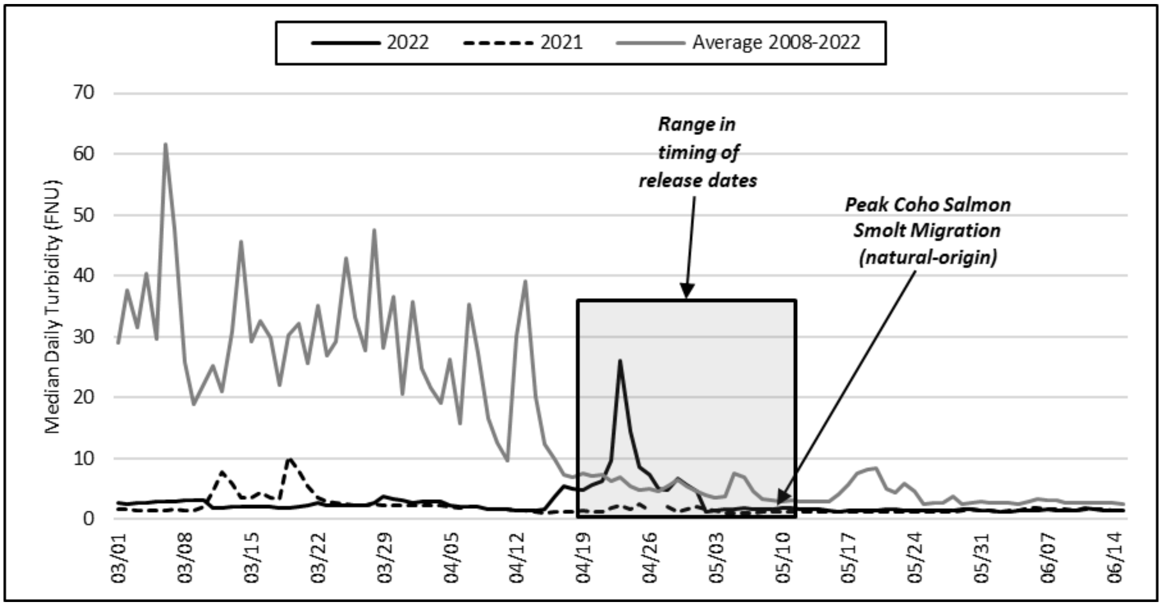


Figure 4-38
Turbidit in the mainstem Russian River (Hacienda USGS Gauge)

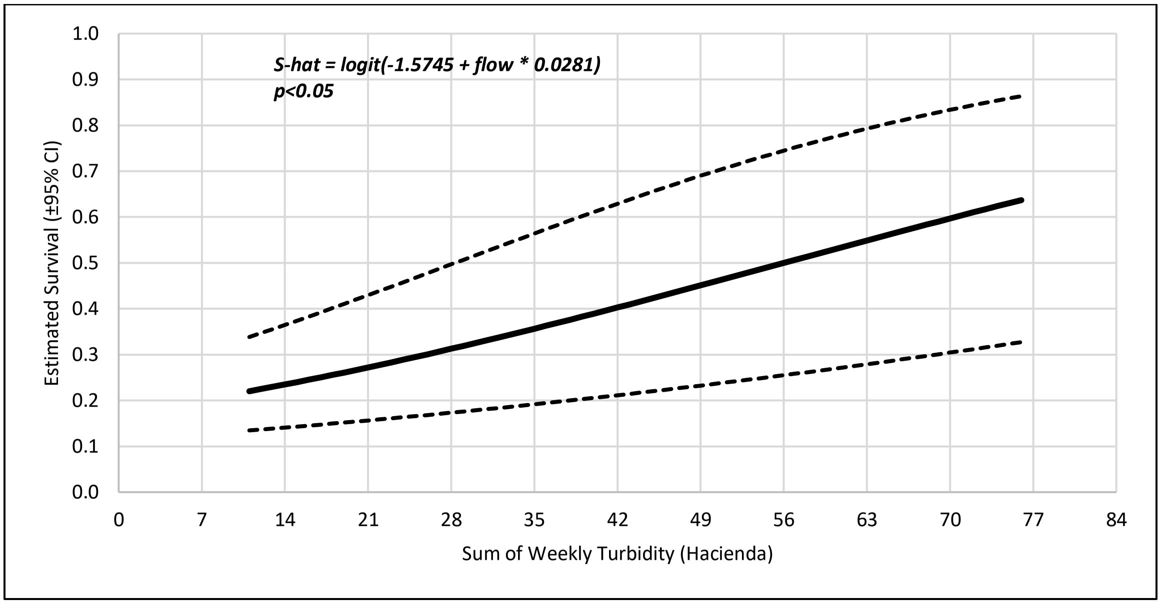


Figure 4-39
Estimated survival as a function of summed weekly turbidity in the mainsteam Russian River (Hacienda USGS Gauge)

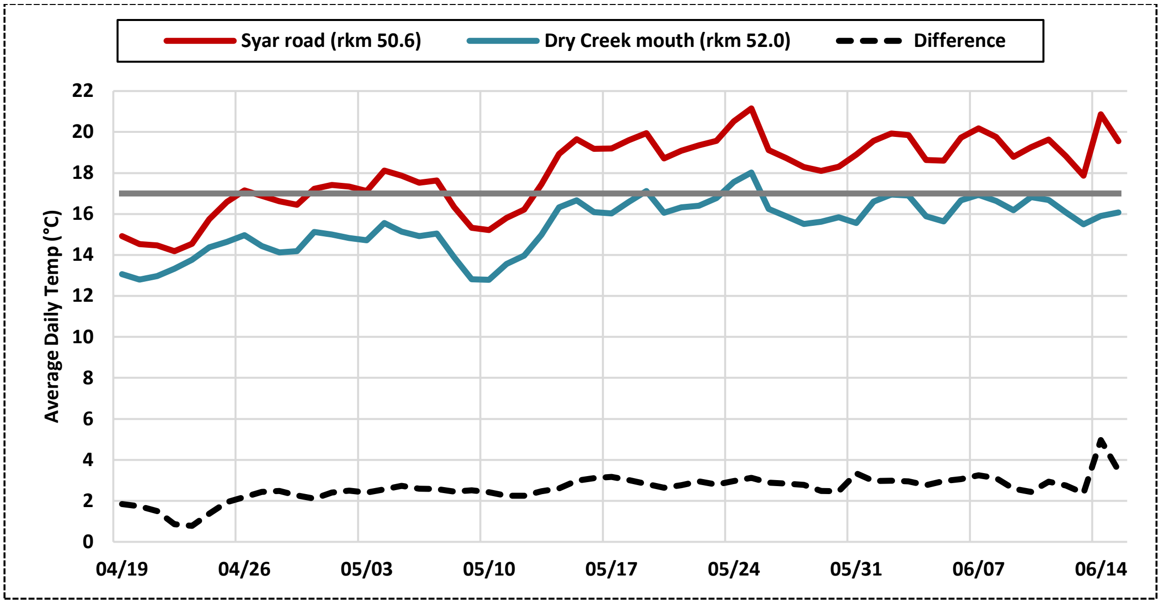


Figure 4-40
Water temperature in Dry Creek (near the Russian River confluence) and Russian River mainstem (near Syar Road gates)

Summary findings from these studies identify the following:

- Trends in survival were identified by release group with survival decreasing from first to last release. These trends appear to be associated with relationships between survival and flow and turbidity. The analysis found positive relationships between higher survival and higher flow, and higher survival and higher turbidity.
- Dry Creek and the Estuary were identified as segments with higher survival compared to the mainstem Russian River. Marked decreases in survival were identified for the reach at the Dry Creek mouth (from the mouth to Syar ponds) and at the Mirabel Dam. Changes in water temperature transitioning between Dry Creek and the mainstem Russian River may be a factor in in this reach; additional research is needed to better understand this mechanism and potential mechanisms associated with Mirabel Dam losses.

Temporary Urgency Change Orders

RPA element 1: *Pursue changes to Decision 1610 Flows*, is focused on Sonoma Water petitioning to change minimum flow requirements under Sonoma Water's water right to operate the Russian River Project permitted by SWRCB Decision 1610. Recognizing that filing such a petition is a multi-year process requiring many rounds of consultation with resources agencies and compliance with the California Environmental Quality Act (CEQA), the RPA element includes pursuing interim changes to Decision 1610 minimum flow requirements annually beginning in 2010. While the RPA element does not include monitoring components, monitoring has been included in the terms and conditions of the TUCOs. In addition to TUCOs for Biological Opinion compliance, Sonoma Water has received multiple TUCOs to address drought conditions since 2008. Drought related TUCOs have also included monitoring requirements and regular coordination with NMFS and CDFW. See Section 4.6.1.2, *Temporary Urgency Change Petitions* for more detail.

Water quality parameters (nutrients, chlorophyl a, pH, temperature, salinity, dissolved oxygen, specific conductance, and turbidity) and pathogens have been monitored in the upper and lower mainstem Russian River, East Fork Russian River at Calpella upstream of Lake Mendocino, East Fork Russian River below Lake Mendocino, and Lake Mendocino according to terms and conditions listed in TUCOs issued by the SWRCB. See Section 4.5.4.5, *Temporary Urgency Change Petition Monitoring Program*.

Adult access to spawning habitat in upper reaches of the mainstem Russian River has been monitored according to terms and conditions listed in TUCOs issued by the SWRCB. Generally, these terms fall into two categories: indirect evidence of inadequate fish passage because of shallow water depth over riffles, and direct observation of adult salmonids and salmonid redds. Depending on the TUCO, season, and hydrologic conditions in the watershed, Sonoma Water conducts riffle crest surveys, snorkel surveys, and spawner surveys.

Coastal Monitoring Program

In 2013, fish monitoring in the Russian River was again expanded when Sonoma Water received funding through CDFW's Fisheries Restoration Grant Program (FRGP) to implement the California Coastal Salmonid Population Monitoring Program[312] (CMP) in the Russian River watershed. This effort is not required by any state or federal regulatory mechanism; however, Sonoma Water and our state and federal partners recognize CMP as a way to collect monitoring data that would help inform relevant management and recovery questions important to the future of Coho Salmon and steelhead in the Russian River watershed. The current CMP effort spans the watershed including the mainstem Russian River and natal tributaries from Lake Mendocino and the West Branch downstream to the Estuary. This allows multi-scale, multi-life stage data to be combined in a manner that allows an accounting of factors that shape populations beyond the Project impacts listed in the *2008 Biological Opinion* while simultaneously gathering unbiased and consistent data to assess progress toward population recovery. Because continued CMP implementation in the Russian is dependent on funds external to Sonoma Water, there is uncertainty whether this portion of Sonoma Water's monitoring program will continue in the future or for how long it might continue.

Wohler Pool Habitat Characterization and Fish Community Monitoring

Sonoma Water began conducting studies to characterize the fish community and habitat conditions in Wohler Pool of the lower Russian River in 1999.[313] [314] [315] Since that time, additional monitoring has continued for various purposes using different methods (total period of monitoring runs from 1999 to present). Sampling techniques have included boat electrofishing,

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[312] Adams, P. B., L. B. Boydstun, S. P. Gallagher, M. K. Lacy, T. McDonald, and K. E. Shaffer. 2011. California coastal salmonid population monitoring strategy design and methods. CA Department of Fish and Game, Sacramento, CA.

[313] Chase et al. 2005. *Op cit.*

[314] Cook 2003. *Op cit.*

[315] Sonoma Water, unpublished data.

operation of screw traps, video counts, and snorkel surveys. As discussed above, NMFS and CDW have expressed concern regarding the status of both native and nonnative predatory fish and associated effects of predation on outmigrating juvenile salmonids, with a particular interest in Wohler Pool. The data summaries presented below characterize the Wohler Pool fish community at large, with a focus on predatory fish.

Boat electrofishing has been a primary sampling technique used in the Pool. For purposes of boat electrofishing the Wohler Pool study area was divided into five reaches (**Figure 4-41**). Reach #1 was located adjacent to Steelhead Beach Regional Park, which is located approximately 2.4 km downstream of the Inflatable Dam. Reach #1 measured approximately one km in length. Reach #2 was located in the lower third of the Wohler Pool, and Reach #3 was located in the middle third of the Wohler Pool. Habitat in the Reaches 2 and 3 is significantly altered by the Inflatable Dam. Reach #4 occupies the upper 1.6 km of the Wohler Pool, and is minimally affected by the dam, with the influence of the dam declining to virtually zero at the upstream end. Reach #5 is above the influence of the impoundment, and consists of natural pools, runs and riffles. Access along the Russian River just above and below the Inflatable Dam (outside the influence of the Dam) is limited. The upstream end of Reach #4 is marked by a shallow riffle and not passable by the electrofishing boat in all years, and thus was not continuously sampled. These limitations prevented the expansion of the study into portions of the river that are not affected by the dam. The upstream end of Reach #5 is similarly truncated by a shallow riffle which restricted this reach to approximately 0.5 km.

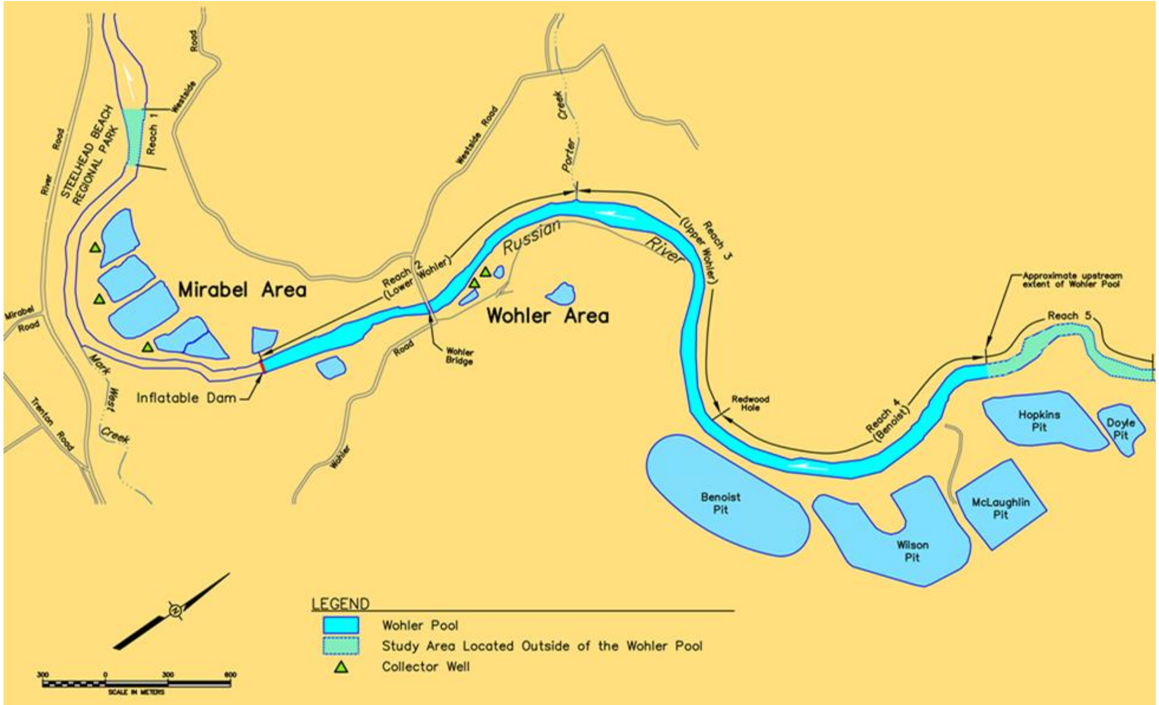

Figure 4-41
Wohler Pool fish community study reaches, Russian River

Species composition of all fish captured during boat electrofishing surveys is represented in **Table 4-36**. During this period, a total of 70,012 total individuals were captured. During the period of sampling, four species of fish, Smallmouth Bass, Sacramento Sucker, Hardhead, and Tule Perch have dominated the fish community above the Inflatable Dam (Reaches 2, 3, and 4). Sacramento Sucker and Smallmouth Bass dominated the catch, when all years and sites are combined (approximately 26.1 percent of the catch, each). Hardhead and Tule Perch ranked 3 (13.8 percent of the catch) and 4 (13.4 percent of the catch), respectively. Pikeminnow were the 5th most abundant species captured, accounting for approximately 5.9 percent of the total catch. Other predatory fish species, including Largemouth Bass, White Catfish, Channel Catfish, and Striped Bass comprised a very low percent of the fish captured. Wild and hatchery salmonids have been collected in relatively low numbers, primarily in reaches above the dam (Wohler Pool).

TABLE 4-36
SPECIES COMPOSITION OF FISH CAPTURED IN THE WOHLER POOL, RUSSIAN RIVER (1999-2019)

Species	Composition
Sacramento Sucker	26.11%
Smallmouth Bass	26.10%
Hardhead	13.83%
Russian River Tule Perch	13.43%
Sacramento Pikeminnow	5.86%
California Roach	3.45%
American Shad	1.84%
Bluegill	1.77%
Sacramento Blackfish	1.73%
Green Sunfish	1.55%
Common Carp	1.16%
Steelhead	0.91%
Largemouth Bass	0.61%
Hitch	0.56%
Redear Sunfish	0.34%
sculpin sp	0.24%
White Catfish	0.15%
Black Crappie	0.12%
Black Bullhead	0.06%
Threespine Stickleback	0.04%
Channel Catfish	0.04%
Striped Bass	0.03%
Golden Shiner	0.02%
Chinook Salmon	0.01%
catfish sp	0.01%
lamprey sp	0.01%
White Crappie	0.01%

All five reaches provide suitable habitat conditions for the two predatory species of concern (see **Table 4-37**). Based on a review of habitat requirements for Smallmouth Bass and catch data, reaches 1, 2, and 3 appear to provide the most suitable habitat. Stream gradient in the Russian River declines below the dam, and there is a higher frequency of pool type habitats compared to the above dam habitat (Chase et al. 2000). The greater depth and lower current velocity associated with pool habitats is preferred by centrarchids (which include Smallmouth). Not surprisingly, Smallmouth Bass dominate the predatory fish population in these reaches.

TABLE 4-37
AVERAGE NUMBER OF PREDATORY FISH BY REACH, WOHLER POOL, RUSSIAN RIVER

Site	Sacramento Pikeminnow	Smallmouth Bass	Largemouth Bass	Striped Bass
Reach 1	20	420	61	0
Reach 2	69	366	6	0
Reach 3	86	363	1	0
Reach 4	86	324	2	0
Reach 5	12	8	0	1

NOTE: Reach locations are shown on Figure 4-41.

As noted above, Smallmouth Bass are the most abundant predatory fish species inhabiting the Wohler Pool; however, the majority of Smallmouth Bass captured were young-of-the-year (see **Table 4-38**). Similarly, Pikeminnow catch was dominated by fish that were age 0+ and 1+, based on size class (<250 mm), which are not likely sufficient size to prey on salmonid smolts (Table 4-36). It is not known if the relatively low number of older Smallmouth Bass and Pikeminnow is due a high rate of mortality, or a high rate of dispersal by young fish to areas outside of the area. Winter habitat conditions (i.e., when the dam is deflated) may at least partially explain the poor recruitment to older age classes. Smallmouth Bass and Pikeminnow attain a size sufficient to prey on salmonid smolts by the start of their third year of life (age 2+).

TABLE 4-38
SACRAMENTO PIKEMINNOW AND SMALLMOUTH BASS SIZE CLASS, WOHLER POOL, RUSSIAN RIVER

	Sacramento Pikeminnow		Smallmouth Bass	
Year	<250 mm	>250 mm	<150 or >300 mm	150-300 mm
2000	97	5	1,082	140
2001	51	16	612	185
2002	151	24	527	118
2003	47	15	432	122
2004	69	15	314	110
2005	5	29	2	24
2006	54	10	112	30
2007	28	54		18
2008	44	33	1	32

TABLE 4-38 (CONTINUED)
SACRAMENTO PIKEMINNOW AND SMALLMOUTH BASS SIZE CLASS, WOHLER POOL, RUSSIAN RIVER

	Sacramento Pikeminnow		Smallmouth Bass	
Year	**<250 mm**	**>250 mm**	**<150 or >300 mm**	**150-300 mm**
2009	2	27		1
2010	2	32		
2011	2	16	1	
2012	127	7	71	12
2013	61	27	25	23
2016	6	27		7
2017	3	42	2	4
2018	1	67	1	7
2019	3	24		5
TOTAL	**753**	**470**	**3,182**	**838**

4.9.5 Sport Angling

The Russian River watershed supports a popular year-round fishery. While take of Chinook and Coho salmon is prohibited, hatchery rearing and marked steelhead may be taken. In the spring, striped bass and American shad are also commonly fished out of the lower river. Since public access is provided throughout the watershed, angling is common throughout accessible reaches from Jenner upstream to Cloverdale. Popular steelhead fishing locations include Wohler Bridge between Forestville and Healdsburg, as well as Steelhead Beach in Forestville off River Road.

The Steelhead Integrated Harvest Hatchery Program assumes that some portion of hatchery steelhead releases will be captured by anglers and factors this into their release targets and broodstock management. Furthermore, part of the purpose of the steelhead program is to provide hatchery fish for harvest. The steelhead HGMP assumes anglers will harvest approximately 50% of the hatchery origin steelhead adults returning to the Russian River each year. On average, anglers are expected to harvest approximately 3,500 adults each year.[316]

While the harvesting of natural origin fish is prohibited, many natural-origin fish are also caught by anglers. The Steelhead Report and Restoration Card data estimates that approximately 1 natural-origin adult is caught for every 2 hatchery-origin steelhead caught be anglers.[317] Although anglers are required to release all natural-origin adults, it is assumed that 5% of the caught natural-origin steelhead are killed due to hooking and handling. From 2006-2015, it is estimated that approximately 400 natural-origin steelhead were caught by anglers in the Russian River. Assuming 5% of these fish were killed, then a total of 20 natural-origin steelhead are killed

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[316] CDFW & USACE, 2021. Op. cit.

[317] The Steelhead Report and Restoration Card is a self-reporting system CDFW uses to track angling trends over time.

on average each year, equaling about 1% of the total Russian River natural-origin steelhead population.

The number of hatchery origin and natural origin steelhead kept and released in Russian River sport fisheries is shown in **Table 4-39**. From 2000 to 2016, a total of 7,967 adult hatchery-origin steelhead have been caught in the basin by anglers and an additional 6,765 released. Because released hatchery steelhead may spawn naturally, the HGMP includes a program to educate anglers to the need and rationale for keeping all hatchery fish caught. Anglers recruited to catch natural origin fish for broodstock will be trained on proper handling procedures for transporting fish from capture point to adult holding facilities or hatchery trucks. Barbless hooks will be used to reduce injury to caught natural-origin fish.

TABLE 4-39
THE NUMBER OF NATURAL-ORIGIN AND HATCHERY-ORIGIN STEELHEAD KEPT AND RELEASED BY ANGLERS IN THE RUSSIAN RIVER AND TRIBUTARIES

Year	Sum of natural-origin (NOR) Kept	Sum of NOR Released	Total NOR	Sum hatchery-origin (HOR) Kept	Sum of HOR Released	Total HOR	Total HOR + NOPR
2000	3	16	19	6	19	25	44
2001	2	101	103	99	128	227	330
2002	2	84	86	141	132	273	359
2003	6	95	101	234	139	373	474
2004	12	187	199	510	439	949	1,148
2005	1	109	110	129	93	222	332
2006	11	189	200	328	225	553	753
2007	94	1,296	1,390	1,568	1,254	2,822	4,212
2008	40	582	622	388	297	685	1,307
2009	14	284	298	323	418	741	1039
2010	6	275	281	162	178	340	621
2011	0	428	428	411	456	867	1,295
2012	0	880	880	1,087	846	1,933	2,813
2013	0	834	834	909	808	1,717	2,551
2014	0	441	441	542	411	953	1,394
2015	0	580	580	763	613	1,376	1,956
2016	0	202	02	379	309	685	887
Total	191	6583	6,774	7,976	6,765	14,741	21,515
Average	11	387	398	469	398	867	1,266
SOURCE: Steelhead HGMP							

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SECTION 5

Status of Species and Critical Habitat

This section identifies the State- (CESA) and federally-listed (FESA) fish species that may occur in the action area. The status, life-history, and distribution are discussed in detail in the following sections to provide the background information against which the effects of the Proposed Action are measured.

5.1 Central California Coast steelhead distinct population segment (DPS)

5.1.1 DPS Overview

The CCC steelhead DPS, includes naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and artificial impassable barriers from the Russian River to and including Aptos Creek, and all drainages of San Francisco and San Pablo Bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers. This also includes steelhead from the following artificial propagation programs:

- Don Clausen Fish Hatchery Program
- Kingfisher Flat Hatchery Program (Monterey Bay Salmon and Trout Project).

The 2016 recovery plan for the CCC steelhead DPS identified the Russian River watershed as an essential, functionally independent population with a spawner abundance target of 8,500 adults.[318]

5.1.2 Listing Status

CCC steelhead DPS are listed as federally threatened. Steelhead were first listed August 18, 1997 (62 CFR 43937). This listing was affirmed on January 5, 2006 (71 CFR 834) and reaffirmed again on April 4, 2014 (79 CFR 20802). Critical habitat was designated for CCC steelhead DPS on September 2, 2005 (70 CFR 52536) and includes all natal spawning and rearing waters, migration corridors, and estuarine areas that serve as rearing areas accessible to listed steelhead in coastal river basins, from the Russian River basin south to the Ano Nuevo Hydrologic sub-area. This area includes the drainages of San Francisco and San Pablo Bays.

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[318] NMFS, 2016. Final Coastal Multispecies Recovery Plan. National Marine Fisheries Service, West Coast Region, Santa Rosa, California.

5.1.3 Life History and Habitat Requirements

Steelhead spend anywhere from one to five years in the ocean, however, two to three years are most common.[319] The distribution of steelhead in the ocean is not well known. Coded wire tag recoveries indicate that most steelhead tend to migrate north and south along the continental shelf.[320] Only "winter run" steelhead are found in the CCC steelhead DPS. The timing of upstream migration is correlated with seasonal high flows and associated lower water temperatures. Steelhead begin returning to the Russian River in December, with the run continuing into April. The minimum stream depth necessary for successful upstream migration is about 18 cm. and the preferred water velocity for upstream migration is in the range of 40-90 cm/s, with a maximum velocity, beyond which upstream migration is not likely to occur, of 240 cm/s.[321] Most spawning takes place from January through April. In contrast to other species of the genus *Oncorhynchus,* steelhead are iteroparous (they may spawn in multiple return years), but most adult steelhead in a given return year are first time spawners.[322]

An important life history for steelhead includes juveniles that rear in freshwater all year. Because of this, adequate stream flow and temperature are important to the population at all times. Emigration appears to be more closely associated with size than age. Generally, throughout their range in California, steelhead that are successful in surviving to adulthood spend at least two years in freshwater before emigrating downstream but important exceptions exist in cases where fish can take advantage of high growth rate conditions including estuarine rearing. In Waddell Creek, Shapovalov and Taft (1954) found steelhead juveniles migrating downstream at all times of the year with the largest numbers of age- 0+ and yearling steelhead moving downstream during spring and summer.

Spawning female steelhead choose sites usually near the tail-outs of pools, where water changes from a laminar to a turbulent flow and there is small to medium gravel substrate. Reiser and Bjornn (1979) found that gravels of 1.3-11.7 cm in diameter were preferred by steelhead. The survival of embryos is reduced when fines smaller than 6.4 millimeters (mm) comprise 20 to 25 percent of the substrate. Studies have shown a higher survival of embryos when intra-gravel velocities exceed 20 cm/hr.[323,324] The number of days required for steelhead eggs to hatch is

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[319] Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F. William Waknitz, and I.V. Lagomarsino. 1996. Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California. National Marine Fisheries Service, National Oceanic and Atmospheric Administration. 261 pages.

[320] Barnhart, R.A. 1986. *Op. cit.*

[321] Thompson, K. 1972. Determining stream flows for fish life. Pages 31-50. Pacific Northwest River Basins Commission; Instream Flow Requirement Workshop, Portland, Oregon.

[322] Shapovalov, L., and A.C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. Inland Fisheries Branch, California Department of Fish and Game.

[323] Coble, D.W. 1961. Influence of water exchange and dissolved oxygen in redds on survival of steelhead trout embryos. Transactions of the American Fisheries Society 90:469-474.

[324] Phillips, R.W., and H.J. Campbell. 1961. The embryonic survival of coho salmon and steelhead trout as influenced by some environmental conditions in gravel beds. Pages 60-73. Pacific Marine Fisheries Commission; Oregon State University; Oregon State Game Commission Research Division, Corvallis.

inversely proportional to water temperature and varies from about 19 days at 15.6°C to about 80 days at 5.6°C. Fry typically emerge from the gravel two to three weeks after hatching.[325]

Upon emerging from the gravel, fry rear in edgewater habitats and move gradually into pools and riffles as they grow larger. Instream cover is an important habitat component for juvenile steelhead both as velocity refuge and as a means of avoiding predation. However, in contrast to summer rearing habitat of other stream-dwelling species of salmonids, steelhead tend to use riffles and other habitats not strongly associated with cover. Young steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles. In winter, they become inactive and hide in any available cover, including gravel or woody debris.

Water temperature influences juvenile steelhead growth rates, population density, swimming ability, their ability to capture and metabolize food, and withstand disease.[326] Rearing steelhead juveniles prefer water temperatures of 7.2 to 14.4°C and have an upper lethal limit of 23.9°C; however, they can survive short periods up to 27°C with saturated dissolved oxygen (DO) conditions and a plentiful food supply. Fluctuating diurnal water temperatures also aid in survivability of salmonids.[327]

Low DO levels decrease juvenile steelhead swimming speed, growth rate, food consumption rate, efficiency of food utilization, threat avoidance behavior, and ultimately survival and DO levels at or below 6.5 to 7.0 mg/l affect the migration and swimming performance of steelhead juveniles at all temperatures.[328] Reiser and Bjornn (1979) recommended that DO concentrations remain at or near saturation levels with temporary reductions no lower than 5.0 mg/l for successful rearing of juvenile steelhead.

During early life stages, suspended and deposited fine sediments can directly affect salmonids by clogging redds, abrading and clogging gills, and indirectly through reduced feeding, slower avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat. Bell (1991) found that suspended silt loads of less than 25 mg/l permit good rearing conditions for juvenile salmonids. It is unlikely that steelhead differ substantially from other salmonids in this respect, so it is assumed this finding applies to steelhead as well.

5.1.4 Distribution in the Russian River Watershed

Based on run timing, steelhead in the Russian River are considered “winter run.” Steelhead are the most widely distributed salmonid in the Russian River watershed, inhabiting many perennial and intermittent streams. Steelhead also utilize portions of the mainstem Russian River as

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[325] Barnhart, R.A. 1986. *Op. cit.*

[326] Bjornn, T.C. and Reiser, D.W. 1991. Habitat requirements of salmonids in streams. Pages 83-138, in M.R. Meehan [editor] Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. W.R. Meehan, editor. American Fisheries Society Special Publication 19.

[327] Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F. William Waknitz, and I.V. Lagomarsino. 1996. *Op. cit.*

[328] Davis, G., J. Foster, C.E. Warren, and P. Doudoroff. 1963. The influence of oxygen concentration on the swimming performance of juvenile pacific salmon at various temperatures. Transactions of the American Fisheries Society 92:111-124.

spawning and rearing habitat. While the majority of steelhead spawning habitat occurs in tributaries some spawning habitat exists in the upper mainstem Russian River. Steelhead spawning habitat in the mainstem (mainly upstream of Cloverdale) and Dry Creek overlaps with Chinook Salmon. Limited steelhead rearing occurs in the mainstem Russian River with peak abundances recorded in the Canyon Reach located between Cloverdale and Hopland and near Ukiah.[329] Limited rearing has also been observed in the mainstem downstream of Dry Creek.[330] Steelhead have also been documented rearing in the lower Russian River near the confluence with Austin Creek and in the Estuary.[331]

Although steelhead are widely distributed in the basin, the overall population is likely depressed compared to historical “estimates” ranging from 50,000 to 57,000 fish; however, these figures are based on anecdotal information with little to no supporting data.[332,333,334,335] The most cited “estimate of the historical steelhead sports catch” is similarly flawed. A Santa Rosa Press Democrat reporter interviewed anglers and “estimated” that 25,000 steelhead were caught in 1957.[336] Rather than representing a typical sports harvest as is generally reported, the article raised concern that a significant portion of the spawning population was being removed and that lower runs might result in following years. Thus, the 1957 sports catch, regardless of its true size, was not representative of an average year’s catch, but may have demonstrated a level where over-fishing was occurring. Still, the popularity of the steelhead fishery provides evidence of a large historical population.

In comparison to other anadromous salmonids in the Russian River, *O. mykiss* exhibit a high degree of variability in life history and can tolerate a wider range of habitat conditions. Adult steelhead enter the Russian River from November through April, although based on hatchery returns peak migration occurs in January through March. Steelhead spawn in the upper mainstem Russian River as well as most accessible tributaries throughout the watershed.[337] Typically, steelhead smolt at age-2+, although age-1+ smolts are more common in some tributaries (e.g., Dry Creek[338]).

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[329] Cook, D G. 2003. "Upper Russian River steelhead distribution study." Sonoma County Water Agency, Santa Rosa, California.

[330] Chase, SD, RC Benkert, DJ Manning, and SK White. 2005. "Sonoma County Water Agency's Mirabel Rubber Dam/Wohler Pool Fish Sampling Program: Year 5 Results: 2004."

[331] The upstream tidal control for the Russian River Estuary is slightly downstream of the Austin Creek confluence (~0.5 km) at Brown’s Riffle.

[332] Evans, W. A. 1959. Coyote Da, Problem, Russian River, Mendocino County. Intraoffice correspondence, Department of Fish and Game, 2.

[333] Hinton, R. N. 1963. Russian River, Sonoma & Mendocino Counties-Army Corps Projects. Memorandum, California Department of Fish and Game.

[334] Vestal, E.H., and R.W. Lassen. 1969. "The Russian River Drainage - a summary report on the fish and wildlife resources and their problems." California Department of Fish and Game.

[335] Anderson, K R. 1972. Report to the California State Water Resources Control Board by the Department of Fish and Game regarding Water Application 18785 and 18786, Lake and Mendocino Counties. Yountville: Environmental Services.

[336] Christensen, W. 1957. Steelhead season 'longest' in history. Santa Rosa, California: The Press Democrat, February 10.

[337] Moyle, P.B. 2002. *Op. cit.*

[338] Chase, SD, RC Benkert, DJ Manning, and SK White. 2005. *Op. cit.*

Adult steelhead migrate through the action area primarily during the winter (December through March) and steelhead smolts emigrate through the action area primarily during the spring (February through May) (**Table 5-1**). Steelhead captured in the rotary screw trap at the Mirabel dam average approximately 175 mm fork length (FL) while juveniles range in size from approximately 30 to 130 mm FL.

TABLE 5-1
PHENOLOGY OF STEELHEAD IN THE RUSSIAN RIVER WATERSHED. DARK AND LIGHT SHADING INDICATE THE PEAK AND RANGE IN TIMING, RESPECTIVELY

Life Stage	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Adult Immigration		░	▓	▓	▓	▓	░					
Spawning			░	▓	▓	▓	░					
Incubation			░	▓	▓	▓	▓	░				
Emergence						▓	▓	▓				
Rearing	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓
Smolt Emigration	░			░	▓	▓	▓	▓	░	░	░	░

SOURCE: National Marine Fisheries Service (NMFS), 2008. Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River Watershed.

5.2 Central California Coho Salmon evolutionarily significant unit (ESU)

5.2.1 ESU Overview

The CCC Coho Salmon ESU, includes naturally-spawned Coho Salmon originating from rivers south of Punta Gorda, California to and including Aptos Creek, as well as Coho Salmon originating from tributaries to San Francisco Bay. This ESU also includes Coho Salmon from the following artificial propagation programs:

- Don Clausen Fish Hatchery Captive Broodstock Program (Russian River watershed)
- Scott Creek/King Fisher Flats Conservation Program
- Scott Creek Captive Broodstock Program.

The 2012 recovery plan for the CCC Coho Salmon ESU identified the Russian River watershed as an essential, functionally independent population with a spawner abundance target of 10,100 adults.[339]

5.2.2 Listing Status

In 1995, the California Fish and Game Commission issued a finding that Coho Salmon south of San Francisco to Monterey Bay warranted listing as endangered under CESA. In March 2005,

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[339] NMFS, 2012. Final Recovery Plan for Central California Coast Coho Salmon (*Oncorhynchus kisutch*) Evolutionarily Significant Unit. National Marine Fisheries Service, Southwest Region, Santa Rosa, California.

Coho Salmon were listed as a threatened species from the Oregon border south to Punta Gorda and as an endangered species from Punta Gorda south to San Francisco, including the Bay.

Under the FESA, CCC Coho Salmon ESU are listed as endangered. Coho were first listed as threatened on October 31, 1996 (61 CFR 56138), that listing was upgraded to endangered on June 28, 2005 (70 CFR 37159). The endangered status was affirmed on April 14, 2014 (79 CFR 56138). Critical habitat for the Central California Coast ESU was designated on May 5, 1999 (61 CFR 56138) and encompasses accessible reaches of all rivers including estuarine areas and tributaries between Punta Gorda and the San Lorenzo River in California. The designations include two streams entering San Francisco Bay: Arroyo Corte Madera Del Presidio and Corte Madera Creek.

5.2.3 Life History and Habitat Requirements

In contrast to the life history patterns of other anadromous salmonids, Coho Salmon in California generally exhibit a relatively simple 3-year life cycle.[340,341] with most individuals emigrating as smolts at age-1+ and returning as adults to spawn at age-3. However, in some populations individuals from the same cohort may smolt at age-2+ and still others may emigrate as age-1+ or age-2+ and return less than 12 months later when they are nearly age-2. The rate of occurrence of the age-2 adult life history varies among watersheds and years. In medium to larger systems that are more likely to be open at the mouth, fish may enter before the fall/winter rainy season but they are still dependent on flow connections to the mainstem in tributary streams. Delays in access to spawning tributaries of over a month are not unusual[342] especially when rains begin later in the season. Adult migration typically tapers off by the end of February with spawning occurring as late as March in some years. Generally, however, peak spawning occurs in December and January, with spawning typically occurring shortly after the fish have access to the spawning grounds.[343]

Coho Salmon are typically associated with small- to moderately-sized coastal streams characterized by heavily forested watersheds, perennially-flowing reaches of cool water, dense riparian canopy, deep pools with abundant cover consisting of large, stable woody debris and undercut banks, and gravel or cobble substrates. Female Coho Salmon choose spawning sites usually near the tail-outs of pools, where water changes from a laminar to a turbulent flow and there is small to medium gravel substrate. Flow characteristics at the redd usually ensure good aeration of eggs and embryos, and the flushing of metabolic waste products. The water circulation in these areas also facilitates fry emergence from the gravel. Preferred spawning habitat often has nearby overhead and submerged cover for holding adults and, water depths of 10 to 54 cm, water

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[340] Shapovalov, L., and A.C. Taft. 1954. *Op. cit.*

[341] Hassler, T.J. 1987. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (pacific southwest) coho salmon. Humboldt State University, California Cooperative Fishery Research Unit; U.S. Fish and Wildlife Service, National Wetland Research Center, Slidell, LA for U.S. Army Corps of Engineers, Coastal Ecology Group, Waterways Experiment Station and for U.S. Department of the Interior, Fish and Wildlife Service, Research and Development, National Wetlands Research Center, Washington, DC, Arcata. 19 Pages.

[342] Eames, M., T. P. Quinn, K. Reidinger, and D. Haring. 1981. Northern Puget Sound 1976 adult coho and chum tagging studies. Pages 1-136. Washington Department of Fisheries Technical Report.

[343] Shapovalov, L., and A.C. Taft. 1954. *Op. cit.*

velocities of 20 to 80 cm/s, clean, loosely compacted gravel (1.3 to 12.7 cm diameter) with less than 20 percent fine silt or sand content, cool water (4 to 10°C) with high DO (8 mg/l), and inter-gravel flow sufficient to aerate the eggs. The lack of suitable gravel often limits successful spawning in many streams. Each female builds a series of redds, moving in an upstream direction. At each redd site, the female creates a hollowed depression in the gravel into which she releases several hundred eggs. As they are deposited, the eggs are fertilized with milt from one or more attending males. The fertilized eggs are then covered with gravel by the female. Briggs (1953) noted a dominant male accompanies a female during spawning, but one or more subordinate males also may engage in spawning. The female may guard a nest for up to two weeks.[344] Fecundity of Coho Salmon is directly proportional to female size with fecundity; at the southern end of the species range (i.e., California and Oregon) averaging approximately 2000 eggs.[345] Coho Salmon are semelparous (they spawn once and then die).

Coho Salmon eggs generally incubate for four to eight weeks, depending on water temperature. Egg survival and development rates depend on temperature and DO levels within the redd. According to Baker and Reynolds (1986), under optimum conditions, egg mortality can be as low as 10 percent, but under adverse conditions of high scouring flows or heavy siltation, mortality may be close to 100 percent. McMahon (1983) found that egg and pre-emergent fry survival drops sharply when fines make up 15 percent or more of the substrate.[346] The newly hatched fry remain in the gravel from two to seven weeks before emergence. According to a review of various literature sources by Bell (1986), the preferred emergence temperatures for Coho range from 4.5-13.3ºC.[347]

Preferred rearing habitat has little or no turbidity and high sustained invertebrate forage production. In streams, juvenile Coho Salmon feed primarily on drifting terrestrial insects, much of which are produced in the riparian canopy, and on aquatic invertebrates growing in the interstices of the substrate and in the leaf litter within pools. In the northern portion of their range, as water temperatures decrease in the fall and winter months, fish stop or reduce feeding due to lack of food or in response to the colder water, and growth rates slow down. During December through February, winter rains result in increased stream flows and by March, following peak flows, fish again feed heavily on insects and crustaceans and grow rapidly.[348] In the Russian River, water temperatures never decrease enough to reduce prey availability such that growth rates are significantly impaired.

In many coastal California systems, Coho Salmon yearlings begin to smoltify and migrate downstream to the ocean during March and April. Out-migration usually peaks in mid-May (**Table 5-2**). Emigration timing is correlated with peak upwelling currents along the coast, which

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[344] Briggs, J. C. 1953. The behavior and reproduction of salmonid fishes in a small coastal stream. Natural History Museum Stanford University California.

[345] Sandercock, F.K. 1991. *Op. cit.*

[346] McMahon, T. E. 1983. Habitat suitability index models: coho salmon. U.S. Department Interior, Fish Wildlife Service. FWS/OBS-82/10.49. 29 pp.

[347] Bell, M.C. 1986. Fisheries handbook of engineering requirements and biological criteria. Fish Passage Development and Evaluation Program. U.S. Army Corps of Engineers. 209 pp.

[348] Gonzales, E. 2006. Diet and Prey Consumption of juvenile Coho Salmon in three northern California stream. Master’s Thesis. Humboldt State University. December 2006.

facilitates higher early marine growth and, therefore, greater marine survival.[349] At this point, smolts are about 10 to 13 cm in length. After entering the ocean, post-smolts initially remain in nearshore waters close to their parent stream. They gradually move northward, staying over the continental shelf.[350] Although they can range widely in the north Pacific, the oceanic movements of California Coho Salmon are poorly understood.

TABLE 5-2
PHENOLOGY OF COHO SALMON IN THE RUSSIAN RIVER WATERSHED. DARK AND LIGHT SHADING INDICATE THE PEAK AND RANGE IN TIMING, RESPECTIVELY

Life Stage	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Adult Immigration	░	█	█	█	░							
Spawning			█	█	█	░						
Incubation			█	█	█	█						
Emergence					█	█	░					
Rearing	█	█	█	█	█	█	█	█	█	█	█	█
Smolt Emigration					░	█	█	█	░			

SOURCE: National Marine Fisheries Service (NMFS), 2008. Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River Watershed.

The amount of time Coho spend in estuarine environments is variable.[351] The extensive trapping studies of Shapovalov and Taft (1954) indicate that nearly all Coho Salmon in Waddell Creek (on the California coast south of the Russian River) migrate downstream as yearlings (age-1+) to enter the marine environment as smolts. Research conducted by Moser et al. (1991), suggests that Coho Salmon smolt migration through estuaries is slower than riverine migration due to the need for a period of estuarine residency that allows for developmental changes in osmoregulatory capability, orientation for their return migration, feeding, and reduction in vulnerability to predators.[352]

The importance of estuaries to juvenile Coho rearing likely varies among watersheds. Reasons include differences in the capacity of non-estuarine habitat to facilitate adequate growth to smolt size as well as differences in the capacity of estuarine habitat to facilitate additional pre-smolt growth as individuals prepare for ocean entry. Estuaries that are confined by steeper valleys may afford less suitable physical habitat than unconfined, low-gradient estuaries which are typically more complex because they allow the formation of sloughs and wetlands. However, water quality conditions even in these unconfined estuaries may limit the ability for individuals in the

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349 Holtby, L.B., B.C. Anderson, and R.K. Kadowaki. 1990. Importance of smolt size and early ocean growth to interannual variability in marine survival of coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences 47:2181-2194.

350 Brown, L.R., P.B. Moyle, and R.M. Yoshiyama. 1994. Historical decline and current status of coho salmon in California. North American Journal of Fisheries Management 14:237-261.

351 CDFG. 2002. Coho salmon distribution. GIS Dataset, California Department of Fish & Game, Northern California, North Coast Region Information Services Branch (NCNCR-ISB), Draft, February 2002.

352 Moser, M.L., A.F. Olson, and T.P. Quinn. 1991. Riverine and estuarine migratory behavior of coho salmon (*Oncorhynchus kisutch*) smolts. Canadian Journal of Fisheries and Aquatic Sciences 48: 1670-1678.

population to osmoregulate in saltwater and withstand higher water temperatures that are characteristic of many estuaries during the summer. Movement of Coho YOY into estuaries has been attributed to displacement from high spring runoff, freshet events during fry emergence, and over-seeding and displacement of subdominant juveniles.[353] Miller and Sadro (2003) and Wallace (2006) found that some Coho YOY that moved to estuaries in the spring remained in the estuary to rear during the summer and appeared to move further upstream in the estuary in fall and winter. Both studies also suggest that rising water temperatures and salinity caused fish to move upstream in the summer as salinity and water temperature increased.[354,355]

5.2.4 Distribution in the Russian River Watershed

Coho Salmon primarily occupy a small set of streams in the Russian River watershed, primarily from Maacama Creek sub watershed downstream to Willow Creek which enters the Russian River Estuary at rkm 4.3. Coho Salmon do not spawn or rear in the mainstem Russian River, but use it seasonally as a migration corridor. Within the action area, Coho Salmon migrate through the lower Russian River upstream as far as Maacama Creek with occasional reports of individuals venturing further upstream. Coho spawning and rearing within the action area is limited to the Dry Creek watershed and, to a lesser degree, the Russian River Estuary.

References to Coho Salmon abundances in the Russian River in the historical literature are limited. Rich et al. (1944) stated that the Coho Salmon abundance in the Russian River was "small and sporadic," while Shapovalov reported "appreciable" numbers of Coho Salmon in tributaries to the Russian River near Duncans Mills.[356,357] Although there are no historical quantitative estimates for Coho Salmon, a few qualitative estimates have been reported in the literature. Lee and Baker (1975) cite CDFW in estimating 7,000 Coho Salmon in the Russian River with an annual harvest of 2,000 fish.[358] However, the lack of quantitative data prevents assessing the historical Coho population in the Russian River. More recent surveys conducted in the early 2000s found few juvenile Coho Salmon, and the consensus among local biologists was that the total run of adult Coho Salmon returning to the Russian River was at most in the tens of fish. Against this backdrop, several entities (University of California Cooperative Extension, CDFW, NMFS, USACE and Sonoma Water) established a Captive Broodstock Program designed to reintroduce Coho Salmon back into the streams that historically supported them. Juvenile Coho Salmon were removed from the wild and reared at the Don Clausen Fish Hatchery (DCFH). That program rears captive individuals to maturity, crosses them based on a carefully designed,

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[353] Murphy, M.L., K.V. Koski, J.M. Lorenz, and J.F. Thedinga. 1997. Downstream migrations of juvenile Pacific salmon (*Oncorhynchus kisutch*) smolts. Canadian Journal of Fisheries and Aquatic Sciences 54:2837-2846.

[354] Miller, B A., and S. Sadro, 2003. Residence time and seasonal movements of juvenile coho salmon in the ecotone and lower estuary of Winchester Creek, South Slough, Oregon. Transactions of the American Fisheries Society 132:546-559.

[355] Wallace, M. 2006. Juvenile salmonid use of Freshwater Slough and tidal portion of Freshwater Creek, Humboldt Bay, California. 2003 Annual Report. Inland Fisheries Administrative Report 2006-04. California Department of Fish and Game, Sacramento.

[356] Rich, W H, A C Taft, P R Needham, and R Van Cleve. 1944. "Report on relation of proposed dams on the Russian River, California, to maintenance and development of fish resources." U.S. Bureau of Reclamation, Region II.

[357] Shapovalov, L., 1944. Preliminary report on the fisheries of the Russian River, California. California Department of Fish and Game.

[358] Lee, D P, and P H Baker. 1975. Eel-Russian River streamflow augmentation study: reconnaissance fisheries evaluation. California Department of Fish and Game.

genetically-based spawning matrix and rears their offspring until release into the wild. Juveniles were released into streams that historically supported Coho Salmon with the expectation that they would complete their life cycle and return to spawn in those streams thereby reestablishing a viable population in the Russian River Basin. Recent Coho Salmon returns, redd counts, and natural-origin juveniles indicate that the program is meeting the objective of making progress toward population recovery.

5.3 California Coastal Chinook Salmon ESU

5.3.1 ESU Overview

The California Coastal Chinook Salmon evolutionarily significant unit (CC Chinook Salmon ESU) includes naturally spawned Chinook Salmon originating from rivers and streams south of the Klamath River to and including the Russian River. The 2016 recovery plan for the CC Chinook Salmon ESU identified the Russian River watershed as an essential, functionally independent population with a spawner abundance target of 9,300 adults.[359]

5.3.2 Listing Status

CC Chinook Salmon are listed as federally threatened. Chinook were first listed September 6, 1999 (70 CFR 50394). The threatened listing was affirmed on June 28, 2005 (70 CFR 37159) and reaffirmed on April 14, 2014 (79 CFR 20802). Critical habitat was designated on September 2, 2005 (70 CFR 52536) and includes all natal spawning and rearing waters, migration corridors, and estuarine areas that serve as rearing areas accessible in coastal river basins, from Redwood Creek south to the Russian River.

5.3.3 Life History and Habitat Requirements

Chinook Salmon exhibit two main life history strategies: “ocean type” and “river type”.[360] Ocean type fish typically are fall or winter run fish that spawn shortly after entering freshwater, and their offspring emigrate shortly after emergence from the redd. The CC Chinook Salmon are fall-run, ocean-type fish.

Chinook Salmon in the CC Chinook Salmon ESU generally remain in the ocean for two to five years and tend to stay along the California and Oregon coasts. CC Chinook Salmon usually enter rivers from August to January. These fall-run Chinook Salmon typically enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower-river tributaries, and spawn within a few weeks of freshwater entry. However, in some populations individuals from the same cohort may return 1 to 4 years earlier than other individuals from the same cohort. The age of adult return varies among years and watersheds but is typically comprised of fish 2 to 4 years old. Spawn timing is, in part, a response to stream flow

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[359] NMFS, 2016. *Op. cit.*

[360] Healey, M.C. 1991. Life history of Chinook salmon (*Oncorhynchus tshawytscha*). Pages 312-393 in C. Groot and L. Margolis, editors. Pacific Salmon Life Histories. University of British Columbia Press, Vancouver.

characteristics, with most spawning occurring in November and December. CC Chinook typically spawn in the lower reaches of rivers and tributaries at elevations of 200 to 1,000 feet.

Egg deposition must be timed to ensure that fry emerge during the following spring at a time when the productivity is sufficient for juvenile survival and growth. Spawning generally occurs in swift, relatively shallow riffles or along the edges of fast runs at depths greater than 24 cm. Optimal spawning temperatures range between 5.6 and 13.9°C. Redds vary widely in size and location within the river. Preferred spawning substrate is clean, loose gravel, mostly sized between 1.3 and 10.2 cm, with no more than 5 percent fines.[361] Gravels are unsuitable when they have been cemented with clay or fines or when sediments settle out onto redds, reducing inter-gravel percolation. Minimum inter-gravel percolation rate depends on flow rate, water depth, and water quality. The percolation rate must be adequate to maintain oxygen delivery to the eggs and remove metabolic wastes. The need for a constant level of subsurface flow may limit suitable spawning habitat. After depositing eggs in redds, adult Chinook Salmon guard the redd from 4 to 25 days. Chinook Salmon are semelparous (they spawn once and then die).[362]

Chinook Salmon eggs incubate for 90 to 150 days, depending on water temperature. Successful incubation depends on several factors including DO levels, temperature, substrate size, amount of fine sediment, and water velocity. Maximum survival of incubating eggs and pre-emergent fry occurs at water temperatures between 5.6 and 13.3°C with a preferred temperature of 11.1°C. Fry emergence begins in December and continues into mid-April.[363] Emergence can be hindered if the interstitial spaces in the redd are not large enough to permit passage of the fry. In laboratory studies, Bjornn and Reiser (1991) observed that Chinook Salmon and steelhead fry had difficulty emerging from gravel when fine sediments (6.4 mm or less) exceeded 30 to 40 percent by volume.[364]

After emergence, Chinook Salmon fry seek out areas behind fallen trees, back eddies, undercut banks, and other areas of bank cover. As they grow larger, their habitat preferences change.[365] Juveniles move away from stream margins and begin to use deeper water areas with slightly faster water velocities but continue to use available cover to minimize the risk of predation and reduce energy expenditure. Fish size appears to be positively correlated with water velocity and depth.[366] Optimal temperatures for both Chinook Salmon fry and fingerlings range from 12 to 14°C, with maximum growth rates at 12.8°C.[367] Chinook Salmon feed on small terrestrial and aquatic insects and aquatic crustaceans. Cover, in the form of rocks, submerged aquatic vegetation, logs, riparian vegetation, and undercut banks provide food, shade, and protection from predation.

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[361] Allen, M.A., and T.J. Hassler. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest) - Chinook salmon.

[362] Healey, M.C. 1991. *Op. cit.*

[363] Leidy, R.A. 1984. Distribution and Ecology of Stream Fishes in the San Francisco Bay Drainage. Hilgardia 52:1-175.

[364] Bjornn, T.C. and Reiser, D.W. 1991. *Op. cit.*

[365] Everest, F.H., and D.W. Chapman. 1972. Habitat selection and spatial interaction by juvenile Chinook salmon and steelhead trout. Journal of the Fisheries Research Board of Canada 29:91-100.

[366] Chapman, D.W., and T.C. Bjornn. 1969. Distribution of salmonids in streams, with special reference to food and feeding. Pages 153-176 in T.G. Northcote, editor. Symposium on Salmon and Trout in Streams; H.R. Macmillan Lectures in Fisheries. University of British Columbia, Institute of Fisheries.

[367] Boles, G.L. 1988. Water temperature effects on Chinook salmon (*Oncorhynchus tshawytscha*) with emphasis on the Sacramento River: a literature review. California Department of Water Resources, Northern District, Sacramento, CA. 43 Pages.

The low flows, higher temperatures, and sand bars that develop during the summer months in smaller coastal California rivers provide habitat for CC Chinook Salmon that favor an ocean type life history.[368] Typically, that translates into smoltification typically occurring at age-0+. Smolt out-migration typically occurs from April through July.[369] In California, ocean type Chinook Salmon tend to use estuaries and coastal areas for rearing more extensively than river type Chinook Salmon.[370] Brackish water in estuaries moderates the physiological stress that occurs during the parr-smolt transition.

Ocean-type pre-smolt Chinook Salmon migrate downstream immediately after emerging from spawning beds and may take up residence in estuaries while they complete their transition to smolts. In the Sixes River, Oregon, Reimers (1973) reports that the most common juvenile life-history pattern was three months rearing in the river and three months rearing in the estuary. In the Campbell River, British Columbia, juvenile Chinook entered the estuary between April and June, spending 40 to 60 days in low salinity water (0 to 5.5 ppt salinity) before moving into a transition zone (5.5 to 25 ppt salinity) between May and July.[371] After that they move into a more marine zone (>25 ppt salinity). In the Sacramento-San Joaquin River delta, Sazaki (1966) observed that young Chinook Salmon were most abundant from April through June, similar to the timing observed in more northern deltas.[372] However, MacFarlane and Norton (2002) demonstrated little estuarine dependency for juvenile Chinook Salmon in the San Francisco estuary.[373]

5.3.4 Distribution in the Russian River Watershed

Based on run timing, Chinook Salmon inhabiting the Russian River are considered “fall-run.” Chinook Salmon occupy the upper and lower Russian River seasonally from the Estuary upstream into the West Fork Russian River, as well as Dry Creek. Chinook Salmon spawn in the Russian River, primarily upstream of Healdsburg and in Dry Creek. There are also documented spawning occurrences in a few tributaries of the Russian River. Although historical estimates of salmonid populations abound in the Russian River literature, virtually all are based on anecdotal information and not on quantitative counts of fish.[374] The accuracy of the anecdotal estimates cannot be assessed. The only quantitative estimate of a salmonid population in the Russian River are the video counts of Chinook Salmon migrating past the Mirabel fish ladders conducted by Sonoma Water.

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[368] Hooton, B., S. Jacobs, M. Jennings, K. Kostow, B. McPherson, T. Nickelson, S. Al, and H. Weeks. 1995. Biennial Report on the Status of Wild Fish in Oregon. Oregon Department of Fish and Wildlife.

[369] Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. *Op. cit.*

[370] Thorpe, J.E. 1994. Salmonid Fishes and the Estuarine Environment. Estuaries 17(1A): 76-93

[371] Reimers, P.E. 1973. The length of residence of fall Chinook in Sixes River, Oregon. Research Report of the Fisheries Commission of Oregon 4(2):43 pages.

[372] Sazaki, S. 1966. Distribution and food habits of king salmon, *Oncorhynchus tshawytscha*, and steelhead rainbow trout, *Salmo gairdnerii*, in the Sacramento-San Juaquin delta, pages 108-114. In: J.L. Turner and D.W. Kelly (comp.). Ecological studies of the Sacramento-San Joaquin Delta. California Department of Fish and Game Fisheries Bulletin 136

[373] MacFarlane, R.B., E.C. Norton. 2002. Physiological ecology of juvenile Chinook salmon (*Oncorhynchus tshawytscha)* at the southern end of their distribution, the San Francisco estuary and gulf of the Farallones, California. Fishery Bulletin 100(2):244-257.

[374] Chase, S D, D J Manning, D G Cook, and S K White. 2007. *Op. cit.*

There are few references to the occurrence of anadromous salmonids in the Russian River prior to 1900. Although lacking in detail, accounts suggest the presence of Chinook Salmon in the Russian historically. The earliest record of a salmon fishery found for Sonoma County was from 1888.[375] The U.S. Commission of Fish and Fisheries (USFCC) described a commercial fishery consisting of 19 men gillnetting "winter salmon" from the Russian River (salmonids were not identified to species). In 1888, 33,597 pounds of salmon were captured by commercial fisherman and shipped to San Francisco. In addition, local consumption of fish (multiple species) was estimated at 150,000 pounds. The report observed that the commercial fishery of the Russian River had become "rather unimportant" by 1888 but had been noted for its abundance of salmon. Overfishing was cited as the reason for the decline.

Although Chinook Salmon are considered native to the Russian River, reports from the 1940s and 1950s indicate that the population was never very large.[376,377] CDFW memos from the 1940s and 1950s stated that few, if any, Chinook Salmon inhabited the river (although a few sources did suggest Chinook Salmon were observed in the Russian River). Rich et al. (1944) does not mention Chinook Salmon in a report discussing the fishery of the Russian River for 1941.[378] An internal memo reported that CDFW hatchery Chinook Salmon released into the Russian River resulted in a minor fishery, but that the fish were unable to reproduce successfully.[379] Steiner (1996) concluded that very few Chinook Salmon were presently in the Russian River basin.[380]

Similar to the 1940s, Sonoma Water fishery biologists in 1999 concluded that few Chinook Salmon inhabited the watershed. However, a juvenile trapping program and the operation of underwater video cameras documented a robust, self-sustaining Chinook Salmon population. Adult Chinook Salmon have been observed at the Mirabel fish counting station as early as August through at least early February; however, the adult upstream migration consistently peaks in October and November (**Table 5-3**). Chinook Salmon are limited to streams with sufficient flow to allow upstream migration and spawning during the fall/early winter timeframe, which is provided primarily in the mainstem Russian River, upstream of Healdsburg, and in Dry Creek.[381]

Juvenile Chinook emigrate downstream from approximately late-February through July, with peak emigration from mid-April through mid-May. It is likely that the extended migration period in the Russian River is related to the anomalous conditions created in Dry Creek.[382] The cold water released from Lake Sonoma masks the seasonal cues that occur in the rest of the watershed. While water temperatures exceed 20ºC by mid-May in the Russian River upstream of

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[375] USFCC. 1892. Part XVL. Report to the Commissioner for 1888 (Jul 1, 1888 - June 30 1889.Salmon Fisheries of the Pacific Coast. Washington D.C.: Government Printing Office.

[376] Snyder, J O. 1908. "The fauna of Russian River, California, and its relation to that of the Sacramento." Science 685: 269-271.

[377] Winzler and Kelly Inc. 1978. "Evaluation of fish habitat barriers to fish migration: Russian River mainstem and lower Dry Creek." Prepared for the US Army Corps of Engineers.

[378] Rich, W H, A C Taft, P R Needham, and R Van Cleve. 1944. *Op. cit.*

[379] Jensen, P.T. 1973. "Russian River King Salmon Program." Memorandum, California Department of Fish and Game.

[380] Steiner Environmental Consulting. 1996. "A history of the salmonid decline in the Russian River." Prepared for the Sonoma County Water Agency and the California State Coastal Conservancy.

[381] Chase, S D, D J Manning, D G Cook, and S K White. 2007. *Op. cit.*

[382] Martini-Lamb, J. and Manning, D., 2020. Op. cit.

Healdsburg, water temperatures in Dry Creek are typically 4-5ºC cooler during this period. Chinook Salmon captured in the rotary screw trap at the Mirabel dam site have an average size of 90 mm fork length (range 32 to 140 mm). Few smolts are captured in the Estuary after June, suggesting that rearing is limited in the Estuary.

TABLE 5-3
PHENOLOGY OF CHINOOK SALMON IN THE RUSSIAN RIVER WATERSHED. DARK AND LIGHT SHADING INDICATE THE PEAK AND RANGE IN TIMING, RESPECTIVELY

Life Stage	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Adult Immigration	■	■	■	░								░
Spawning	░	■	■	■	░							
Incubation	░	■	■	■	■	░						
Emergence				░	■	■	░					
Rearing				░	■	■	■	■	░			
Smolt Emigration					░	■	■	■	░	░		

SOURCE: National Marine Fisheries Service (NMFS), 2008. Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River Watershed.

5.4 Longfin Smelt Bay-Delta DPS

5.4.1 DPS Overview

On April 2, 2012, USFWS concluded that the population of Longfin Smelt in the San Francisco Bay-Delta was a valid DPS and was warranted for listing under FESA (77 FR 19756). Since that time, additional genetic information has become available to further support the USFWS DPS conclusion that the population is both discrete and significant (Saglam et al. 2021; USFWS 2022). Because Longfin Smelt has not been formally listed under FESA (currently proposed), critical habitat for the DPS has not been designated. However, USFWS has identified the range of the species, which includes the Bay-Delta and ocean habitat immediately offshore and to the south of the Russian River Estuary (approximately 96 km north of the Bay-Delta estuary); the proposed listing has not specified whether the Russian River Estuary is considered in this range (87 FR 60957). As a result, it is currently unclear that the Bay-Delta DPS would include specimens potentially occurring in the Russian River Estuary. Further, there are questions regarding whether or not Longfin Smelt originating from the Bay-Delta could complete northern ocean migrations from the Bay-Delta to the Russian River Estuary, against the north to south California current. Additional discussion on species distribution is provided below.

5.4.2 Listing Status

Longfin Smelt was listed as threatened under CESA in 2009. The USFWS concluded that Longfin Smelt did not warrant listing throughout their range as endangered or threatened under FESA, but that the San Francisco Bay-Delta DPS of Longfin Smelt did warrant listing.

Subsequently, in October of 2022, USFWS proposed listing the Longfin Smelt Bay-Delta DPS as endangered under FESA (87 FR 60957; published October 7, 2022).

As stated above, because Longfin Smelt has not been formally listed under FESA (currently proposed), critical habitat has not been designated.

5.4.3 Life History and Habitat Requirements

Much of the existing demographic information on Longfin Smelt comes from San Francisco Bay.[383,384,385,386,387] Garwood (2017)[388] conducted a comprehensive data review to gather, synthesize and analyze all available contemporary and historic information on Longfin Smelt distribution and habitat associations in areas of California outside of San Francisco Bay.

Longfin Smelt is distinguished from other California smelt by the long pectoral fins that nearly reach the bases of the pelvic fins. Longfin Smelt are euryhaline, meaning they can tolerate a wide range of salinity from completely fresh to marine. Longfin Smelt is also anadromous, depending on fresh and marine waters for spawning and rearing.

Longfin Smelt typically live for two years, reaching lengths of about 90-124 mm FL, but can live a third year reaching maximum length of about 150 mm FL.[389,390] Larvae move up and down in the water column to maintain position within the mixing zone of the estuary where foraging on small shrimp-like crustaceans occurs.[391]

Larval survey data from the Bay-Delta indicate spawning occurs from November through May, with a peak from February through April. Spawning in California is inferred from the presence of newly-hatched larvae. Eggs are thought to be released in freshwater over sandy, or gravel substrates, rocks and aquatic plants; each female can lay between 5,000 and 24,000 adhesive eggs.[392] Longfin Smelt is known to be a semelparous species, meaning they die after spawning.

Until recently, suitable salinity and habitat for spawning was thought to occur only in upper estuaries, after which, downstream flows transported early-stage, surface-oriented larvae to

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[383] Baxter, R., K. Hieb, S. DeLeon, K. Fleming, and J. Orsi. 1999. Report on the 1980-1995 Fish, Shrimp, and Crab Sampling in the San Francisco Estuary. James Orsi, Editor. The Interagency Ecological Program for the Sacramento-San Joaquin Estuary, Technical Report 63, Stockton, California.

[384] Bennett, W. A., W. J. Kimmerer, and J. R. Burau. 2002. Plasticity in Vertical Migration by Native and Exotic Estuarine Fishes in a Dynamic Low-Salinity Zone. *Limnology and Oceanography* 47(5):1496-1507.

[385] Rosenfield, J. A., and R. Baxter. 2007. Population Dynamics and Distribution Patterns of Longfn Smelt in the San Francisco Estuary. *Transactions of the American Fisheries Society* 136(6):1577-1592.

[386] Merz, J. E., P. S. Bergman, J. F. Melgo, and S. Hamilton. 2013. Longfn Smelt: Spatial Dynamics and Ontogeny in the San Francisco Estuary, California. *California Fish and Game* 99(3):122-148.

[387] Garwood, R.S. 2017. Op. cit.

[388] Garwood, R.S. 2017. *Op. cit.*

[389] Baxter et al. 1999. *Op. cit.*

[390] Moyle, P.B. 2002. *Inland Fishes of California*. University of California Press. Berkeley, California. USA.

[391] Garwood, R.S. 2017. *Op. cit.*

[392] Moyle, P.B. 2002. *Op. cit.*

seaward regions of the estuaries.[393] As larvae develop (>10 mm), their distribution shifts to the center of channels and deeper in the water column, where they use vertical migration to maintain their position near the low-salinity zone.[394,395,396] Recent discoveries of newly hatched larvae in seaward regions in years with high outflow suggest novel variation in migration distance, suitable habitat, and interactions with waterflow deserve further examination.[397,398,399]

Longfin Smelt exhibits complex life history patterns, using a variety of habitats from nearshore waters, to estuaries and lower portions of freshwater streams. While consistent data collection efforts in the greater San Francisco Bay-Delta region provide much information regarding this species, less is known throughout its remaining range in California, including its distribution in the Russian River Estuary.

Some adult Longfin Smelt from the San Francisco Bay-Delta population exhibit anadromy, but the influence of this migratory behavior on recruitment success and population connectivity is not clear.[400,401,402] Migration may support resilient populations through recruitment of larvae and via gene flow of adaptive traits; therefore, it is important to understand the potential for connectivity among Longfin Smelt populations along the California coast.[403]

5.4.4 Distribution in the Russian River Estuary

Trawl surveys conducted from summer or early fall through mid-November in the lower Russian River over four years (from 1997 through 2000) resulted in Longfin Smelt detections near the mouth of the river with detections occurring in late August through early November.[404,405,406,407]

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[393] Hieb K, Baxter R. 1993. Delta outflow/San Francisco Bay. *1991 Annual Report*. Interagency Ecological Studies Program for the Sacramento–San Joaquin Estuary. Sacramento (CA): California Dept. of Water Resources. p. 101– 116.

[394] Hieb K, Baxter R. 1993. *Op. cit.*

[395] Bennett et al. 2002. *Op. cit.*

[396] Dege M, Brown LR. 2003. Effect of outflow on spring and summertime distribution and abundance of larval and juvenile fishes in the upper San Francisco Estuary. *Proc Am Fish Soc* Symposium American Fisheries Society. p. 49–66.

[397] Grimaldo L, Burns J, Miller RE, Kalmbach A, Smith A, Hassrick J, Brennan C. 2020. Forage fish larvae distribution and habitat use during contrasting years of low and high freshwater flow in the San Francisco Estuary. *San Franc Estuary Watershed Sci*.;18(3).

[398] Lewis LS, Willmes M, Barros A, Crain PK, Hobbs JA. 2020. Newly discovered spawning and recruitment of threatened Longfin Smelt in restored and underexplored tidal wetlands. *Ecology* 101;(1):e02868.

[399] Brennan, C.A., J.L. Hassrick, A. Kalmbach, D.M. Cox, M.C. Sabal1, R.L. Zeno, L.F. Grimaldo, S. Acuña. 2022. Estuarine Recruitment of Longfin Smelt (*Spirinchus thaleichthys*) North of the San Francisco Estuary. *San Francisco Estuary and Watershed Science*; 20, 3, 3.

[400] Rosenfield and Baxter. 2007. *Op. cit.*

[401] Brennan et al. 2022. *Op cit.*

[402] Garwood RS. 2017. *Op. cit.*

[403] Brennan et al. 2022. *Op cit.*

[404] Merritt Smith Consulting. 1998. Biological and Water Quality Monitoring in the Russian River Estuary, 1997 - Second Annual Report. Prepared for the Sonoma County Water Agency.

[405] Merritt-Smith Consulting. 1999. Biological and Water Quality Monitoring in the Russian River Estuary, 1998 - Third Annual Report. Prepared for the Sonoma County Water Agency.

[406] Merritt-Smith Consulting. 2000. Biological and Water Quality Monitoring in the Russian River Estuary, 1999 - Fourth Annual Report.

[407] Sonoma County Water Agency. 2001. Biological and Water Quality Monitoring in the Russian River Estuary, 2000 - Fifth Annual Report.

Three individuals were also collected in June. Longfin Smelt were not detected in the upstream stations also trawled during the study. In addition, while Longfin Smelt were captured in trawl surveys, they were not detected in the corresponding shallow water beach seine collections in the lower Estuary.[408] This indicates Longfin Smelt were utilizing the deeper, cooler, more saline waters of the Estuary. The timing of observations in the Russian River Estuary indicates individuals may have been staging in the Estuary prior to spawning, though it is unclear where spawning might occur in the Estuary.[409]

More recently, Brennan et al. (2022) investigated the distribution and habitat associations of larval Longfin Smelt in 16 estuaries along the Pacific coast that historically contained them, including the Russian River Estuary.[410] However, Longfin Smelt larvae were only detected in larger estuaries north of Cape Mendocino, where shallow tidal wetlands and sloughs likely promote larvae retention. The study concluded that high flows may have transported larvae out of smaller coastal estuaries, including the Russian River, thereby reducing detectability.[411]

5.5 Trends in Abundance

Indicators of adult salmon and steelhead abundance are derived from a video system at the Mirabel fish ladder, returns to Russian River hatcheries, PIT antenna arrays and spawner surveys. Indicators of juvenile and smolt abundance are derived from beach seining, backpack electrofishing surveys, downstream migrant trapping and PIT antenna arrays. The method used to collect the data reported here depends on the species, life stage and location (i.e., watershed, sub-watershed, stream, reach, site) of interest. Although a given monitoring method may yield data on a non-target species or life stage, those data are not necessarily reported as they are not useful and could be misleading. An example is video monitoring at the Mirabel fish ladder that targets adult Chinook Salmon. Operation of the video system depends on the dam being raised. Because the integrity of the dam is risked at high flows that typically begin in late fall/early winter, the dam is not lowered until early December in most years. This timing is well before the onset of the majority of adult Coho Salmon and steelhead migration but it encompasses the majority of the Chinook Salmon run in most years. Therefore, in the sections that follow, Mirabel video counts are reported for adult Chinook Salmon but they are not reported for adult Coho Salmon or steelhead because those counts would not be good indicators of run size.

Trends in abundance are not provided for Longfin Smelt because of the low and infrequent detections of this species in the Estuary.

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[408] Garwood RS. 2017. *Op. cit.*
[409] Garwood RS. 2017. *Op. cit.*
[410] Brennan et al. 2022. *Op cit.*
[411] Brennan et al. 2022. *Op cit.*

5.5.1 Steelhead

5.5.1.1 Adults

Abundance

Returns to Russian River Hatcheries

Perhaps the best indicator of adult steelhead returns to the Russian River is the number of adult returns to DCFH and CVFF (**Figure 5-1**).[412] However, these counts do not take into account returns to other portions of the watershed. Annual adult returns averaged 3,526 fish at DCFH and 2,207 fish at CVFF (5,733 total adults) from winter 2005/06 to 2020/21. Returns ranged from minimums of 870 and 371 at DCFH and CVFF (1,241 total adults), respectively, during winter 2008/09, to maximums of 7,201 and 5,330 (12,531 total adults) at the two facilities during winter 2006/07. Based on steelhead passing the Mirabel dam, hatchery origin fish made up 64.7 percent of the return for all years combined.

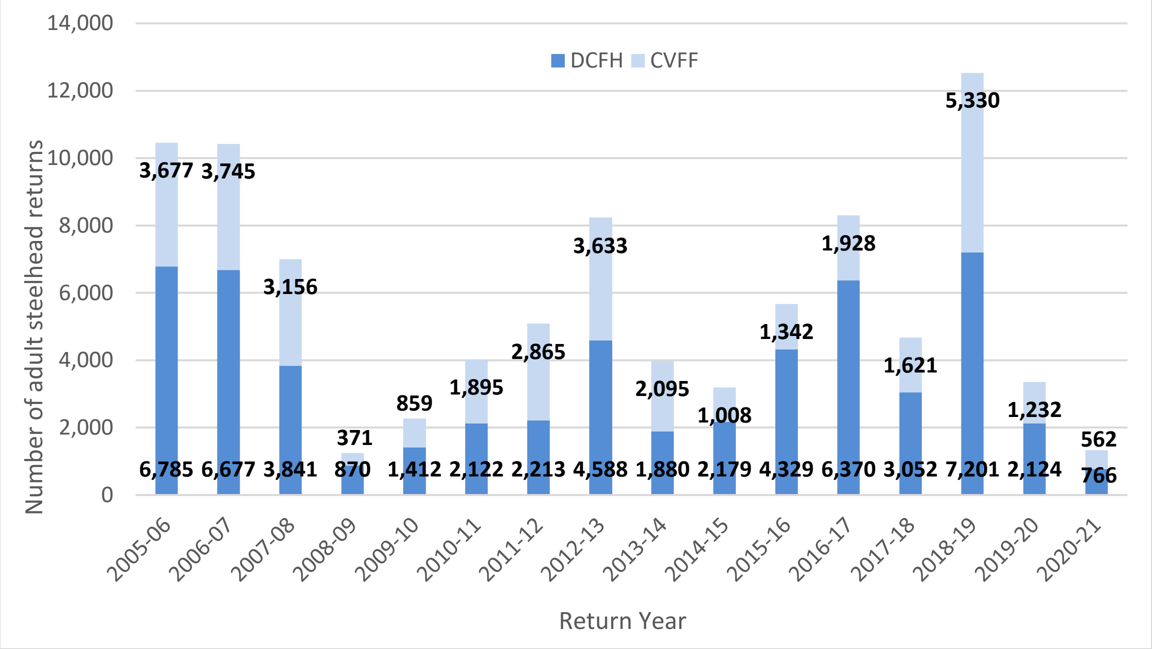

Figure 5-1
Adult Steelhead Returns to DCFH and CVFF

PIT Antenna Detections

A significant steelhead tagging effort began in all life cycle monitoring streams (LCS) in 2019, making the adult return season of 2021/22 the first opportunity to estimate survival of steelhead to the adult stage. However, Sonoma Water was unable to calculate a reliable adult estimate due to the low number of adult steelhead that were detected. For steelhead tagged in late summer of 2019, Sonoma Water observed fish returning to Mill, Green Valley, and Willow Creeks (**Table 5-4**). In the Mill Creek watershed, tagging efforts began in 2017 and Sonoma Water

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[412] CDFW and USACE, 2021. *Op. cit.*

observed fish returning in March 2020, October 2021, December 2021, January 2022 and March 2022. There were no observations of fish returning from the 2018 tagging cohort.

TABLE 5-4
STEELHEAD PIT TAGGED AS PRE-SMOLTS DETECTED AS LIKELY ADULTS RETURNING TO THE RUSSIAN RIVER WATERSHED BY LCS STREAM OF ORIGIN

Life Cycle Stream	Tag Date	Size at Tagging (fork length, mm)	Interval at Large (days)	Return (detection) date
Mill Creek	10/2/2017	74	554	3/26/2020
Mill Creek	10/4/2017	81	1,013	10/24/2021
Mill Creek	9/2/2017	60	1,379	12/30/2021
Mill Creek	10/7/2019	61	812	3/19/2022
Green Valley Creek	9/12/2019	75	626	1/6/2022
Willow Creek	9/24/2019	68	893	3/5/2022
Willow Creek	9/25/2019	64	828	12/31/2021

SOURCE: SCWA and California Sea Grant. 2022. Implementation of California Coastal Salmonid Population Monitoring in the Russian River Watershed. Santa Rosa, CA. 70 pp. + appendices.

Redds

Sonoma Water and CSG conduct salmonid spawner surveys in Russian River tributaries to document spatial distribution and abundance of redds at both individual stream and basinwide scales (**Figure 5-2**).[413,414] To generate stream-specific estimates of redd abundance, all accessible adult spawning reaches of Willow, Dutch Bill, Green Valley, and Mill sub-watersheds have been surveyed each year since 2014. For basinwide estimates conducted as part of the CMP, a generalized random tessellation stratified (GRTS) approach with soft stratification is used to survey a random, spatially-balanced selection of Coho Salmon and steelhead reaches within the Russian River sample frame.[415,416] Prior to winter 2018/19 steelhead abundance was estimated in reaches that also contained Coho habitat, while from 2018/19 to 2020/21, basinwide abundance estimates included all steelhead reaches within the CMP sample frame including reaches that contain Coho habitat. Survey methodology for collecting information on spawning salmonids in the Russian River watershed follows the coastal northern California salmonid spawning survey protocol.[417]

The effects of varying patterns in precipitation are important for understanding the degree to which management actions may be affecting adult salmonid returns. In most years, Russian River tributaries where steelhead spawn and rear become disconnected from the river during the dry summer and fall seasons, thus preventing tributary entry or exit. Significant rain events, which

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[413] Sonoma Water and California Sea Grant. 2022. Implementation of California Coastal Salmonid Population Monitoring in the Russian River Watershed. Santa Rosa, CA. 70 pp. + appendices

[414] Sonoma Water, 2022. Unpublished data.

[415] A sample frame of stream reaches identified by the Russian River Coastal Monitoring Program (CMP) Technical Advisory Committee as having Coho Salmon, steelhead, and/or Chinook Salmon habitat.

[416] Sonoma Water and California Sea Grant. 2019. Implementation of California Coastal Salmonid Population Monitoring in the Russian River Watershed. Santa Rosa, CA. 72 pp. + appendices.

[417] Gallagher, S. P., and M. Knechtle. 2005. Coastal Northern California salmonid spawning survey protocol. California Department of Fish and Game.

typically begin in late November, reconnect the streams and allow adult salmonids to access spawning habitat soon after they enter the river from the ocean. During the winter of 2020/21, late and low rainfall reduced access to spawning habitat, influencing both timing of entry into the tributaries as well as spawning distribution throughout the watershed. Recent atypical patterns in steelhead basinwide redd distribution may be explained by the low flow conditions of winter 2020/21.

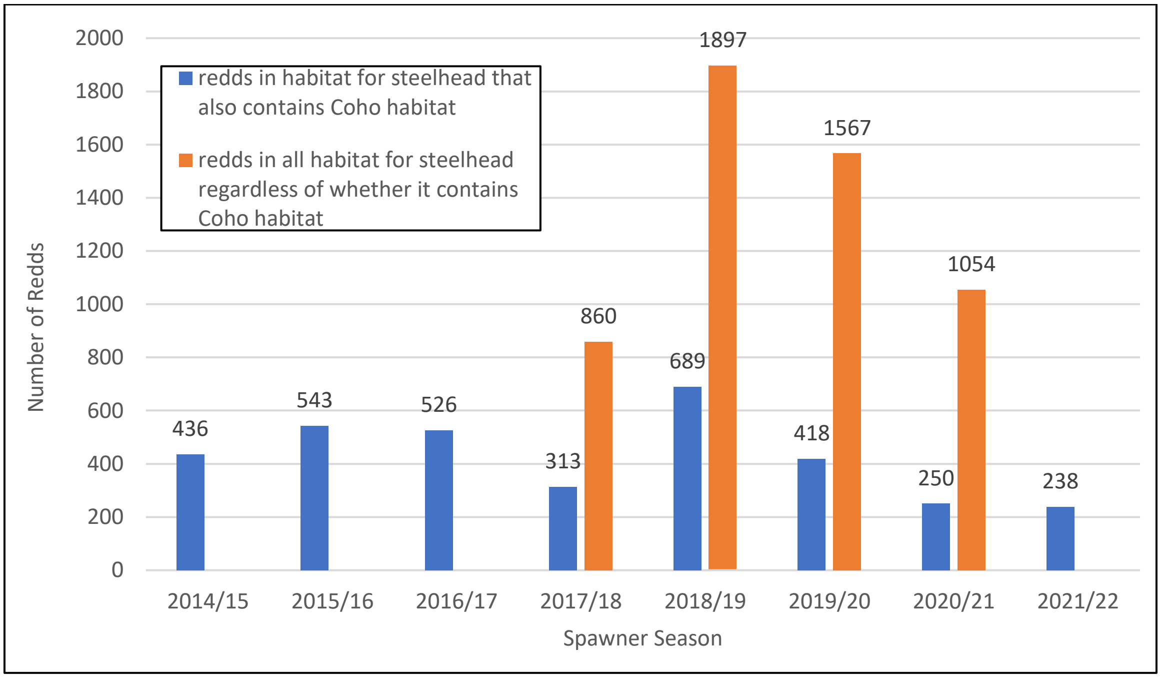

Figure 5-2
Basin-wide estimates of steelhead redds

5.5.1.2 Juveniles

Abundance

Estuary Entry

RPA element 2 of the *2008 Biological Opinion* guides Sonoma Water to provide information about the timing of downstream movements of juvenile steelhead into the Estuary, their relative abundance, and the size/age structure of the population as related to the implementation of adaptive management of the inlet channel during the lagoon management season (May-October). The sampling design implemented by Sonoma Water specifically targets the detection and capture of anadromous salmonid young-of-the-year (YOY, age-0+) and parr (≥age-1+) (collectively referred to as juveniles) as well as smolts. Since 2009, Sonoma Water has maintained a series of downstream migrant traps (DSMTs) and stationary PIT antenna arrays. Additionally, as part of the Broodstock Program, CSG maintains DSMTs and PIT antenna arrays to estimate Coho Salmon smolt abundance, natural production, freshwater survival, migration timing, and freshwater growth. The locations of the DSMT and PIT antenna arrays are summarized in **Table 5-5** and **Figure 5-3**.

TABLE 5-5
SONOMA WATER AND CSG PIT ANTENNA ARRAY AND DOWNSTREAM MIGRANT TRAP LOCATIONS

Watershed Location	PIT Antenna Array	Downstream Migrant Trap
Russian River-Mirabel Dam (Sonoma Water)	2010-2022	2000-2022
Russian River-Northwood (Sonoma Water)	2013-2016	-
Mark West Creek (Sonoma Water)	2017-2022	2012-2022
Dutch Bill Creek (Sonoma Water/CSG)	2011-2022	2010-2022
Austin Creek (Sonoma Water)	2010-2022	2010-2022
Estuary-Duncans Mills (Sonoma Water)	2010-2022	2009-2010
Green Valley Creek (CSG)	2010-2022	2005-2022*
Mill Creek (CSG)	2007-2022	2005-2022
Willow Creek (CSG)	2012-2022	2012-2022

NOTE:

* Trap was not operated in 2006 and 2012-2014.

SOURCE: Sonoma Water, 2022. G. Horton and A. Pecharich personal communication. March 10, 2022.

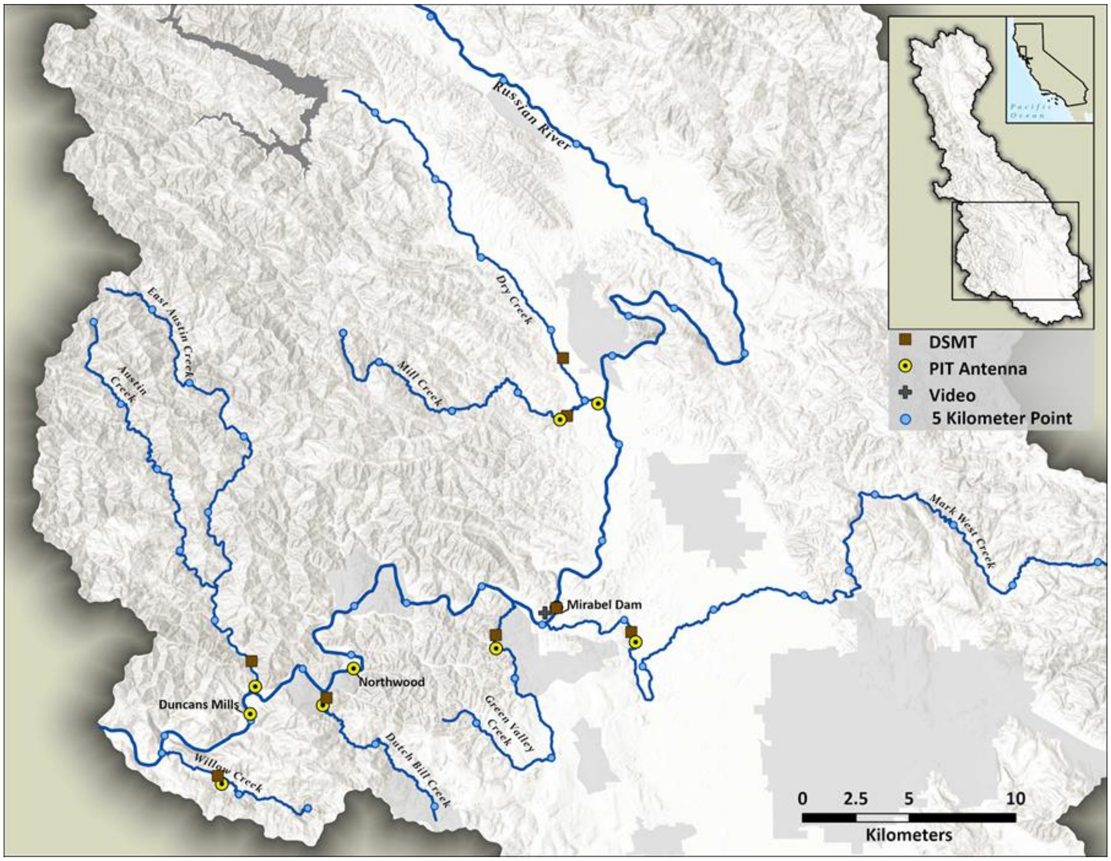

Figure 5-3

PIT Antenna Arrays and Downstream Migrant Trap Locations

In order to help accomplish the objectives listed above for juvenile steelhead related to timing, relative abundance, size, and age structure at Estuary entry, Sonoma Water undertakes fish capture and PIT-tagging activities at selected trapping sites upstream of the Estuary.

Entry is currently tracked through juvenile passage over the Duncan Mills array (rkm 10.46; **Table 5-6**) and by using detections from a paired antenna array in lower Austin Creek (**Table 5-7**). From 2013 to 2016, a paired antenna array at Northwood in the mainstem Russian (rkm 19.16) was also operated with the objective of detecting whether PIT-tagged juvenile steelhead were moving downstream from upstream trapping sites but stopping short of the Estuary. At Austin Creek, a dual PIT antenna array is currently operated approximately 0.2 km downstream of the downstream migrant trap and approximately 0.5 km upstream from Austin Creek mouth in order to detect PIT-tagged steelhead moving out of the creek (Figure 5-3). The PIT antenna array is located at the upstream extent of the area in Austin Creek that can be inundated by the Russian River during closure of the barrier beach. This array is used in conjunction with the array at Duncans Mills (approximately 1.5 km downstream) to calculate antenna efficiency for the PIT antenna array located in Austin Creek (Table 5-7).

Estuary Residence

A beach-deployed seine has been used throughout the Estuary to sample fish species, including salmonids, and determine their relative abundances and distribution within the Estuary. From 2004 to 2009, eight seining stations were located throughout the Estuary in a variety of habitats that included different substrate types (i.e., mud, sand, and gravel), depths, tidal fluctuations, and tributary influences. Beginning in 2010, two additional stations were added to the survey effort, which is conducted from May through October. Recently, seine surveys have been conducted in May, June, and September with additional surveys conducted following closures for extended periods (2 weeks or more). Overall there has been a decline in steelhead abundance since 2008 when the CPUE was 1.32 fish/set (**Figure 5-4**). The seasonal abundance of steelhead captures varies annually in the Estuary with the highest average steelhead abundance typically occurring in May and June. However, the highest single CPUE among all study years was in 2008 at 1.32 fish/set and with a close second in 2005 at 0.82 fish/set.[418] 2022 was the lowest CPUE on record at 0.01 fish/set. No hatchery origin fish have been captured as part of Estuary seining.

Since seining surveys began in 2004, steelhead appear to have a patchy distribution and vary in abundance within the Estuary. Over all years surveyed, captures are typically highest in the upper reach of the Estuary. The typical pattern of steelhead movement within the Estuary consists of relatively large numbers of freshwater-acclimated juvenile steelhead in the upper Estuary in May and June, before moving into the middle Estuary in mid-summer, and then the lower Estuary in September. Spring (May) captures are typically juveniles (age-0+/age-1+) residing in freshwater in the upper Estuary. By late summer the steelhead are mainly saltwater tolerant individuals residing in the brackish water of the lower Estuary.

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[418] J. Martini-Lamb and Manning, D.J. editors. In Progress. Russian River Biological Opinion Status and Data Report Year 2021. Sonoma County Water Agency, Santa Rosa, CA.

TABLE 5-6
NUMBER OF STEELHEAD CAPTURED AT DSMTS, NUMBER PIT TAGGED, AND NUMBER DETECTED ON THE DUNCANS MILLS PIT TAG DETECTION SYSTEM

	2018			2019[a]			2020			2021		
Site	**No. Captured**	**No. PIT-Tagged**	**No. (proportion) detected at Duncans Mills**	**No. Captured**	**No. PIT-Tagged**	**No. (proportion) detected at Duncans Mills**	**No. Captured**	**No. PIT-Tagged**	**No. (proportion) detected at Duncans Mills**	**No. Captured**	**No. PIT-Tagged**	**No. (proportion) detected at Duncans Mills**
Dry Creek	3,867	0	-	5,668	0	-	3,419	0	-	1,989	0	-
Mainstem	241	63	0 (0.0%)	725	40	N/A	204	46	0 (0.0%)	695	100	0 (0.0%)
Mark West Creek	186	62	0 (0.0%)	219	125	N/A	31	14	0 (0.0%)	77	22	0 (0.0%)
Dutch Bill Creek	23	12	1 (8.3%)	144	74	N/A	2,281	176	9 (0.05%)	165	3	1 (0.33%)
Austin Creek	2393	780	74 (9.4%)	403	172	N/A	1,377	382	37 (0.10%)	834	159	2 (0.01%)
Total	**6,710**	**917**	**75 (8.3%)**	**7,159**	**411**	**N/A**	**7,312**	**618**	**45 (0.07%)**	**3,760**	**284**	**3 (0.01%)**

NOTE:
a The Duncans Mills antenna was not operated in 2019.

SOURCE: J. Martini-Lamb and Manning, D.J. editors. *In Progress*. Russian River Biological Opinion Status and Data Report Year 2021. Sonoma County Water Agency, Santa Rosa, CA.

TABLE 5-7
PIT TAG AND TRAP CAPTURE METRICS AND VALUES FOR YOY (>= 60 MM ONLY) IN AUSTIN CREEK

Metric	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Estimated Number of PIT-Tagged YOY Emigrants	632	251	759	1,549	325	32	520	55	93	138	225	61
Estimated Proportion of PIT-Tagged YOY Emigrated	65.8%	77.5%	50%	88.5%	67.3%	76.2%	46.0%	17.2%	40.5%	38%	50%	41.3%
Estimated Population Size of YOY at Trap	21,628	7,426	5,804	NA	NA	NA	6,113	NA	9,791	6,456	N/A	N/A
Estimated Number YOY in Population that Emigrated	14,231	5,755	2,901	NA	NA	NA	2,812	NA	3,965	2,453	N/A	N/A

SOURCE: J. Martini-Lamb and Manning, D.J. editors. *In Progress*. Russian River Biological Opinion Status and Data Report Year 2021. Sonoma County Water Agency, Santa Rosa, CA.

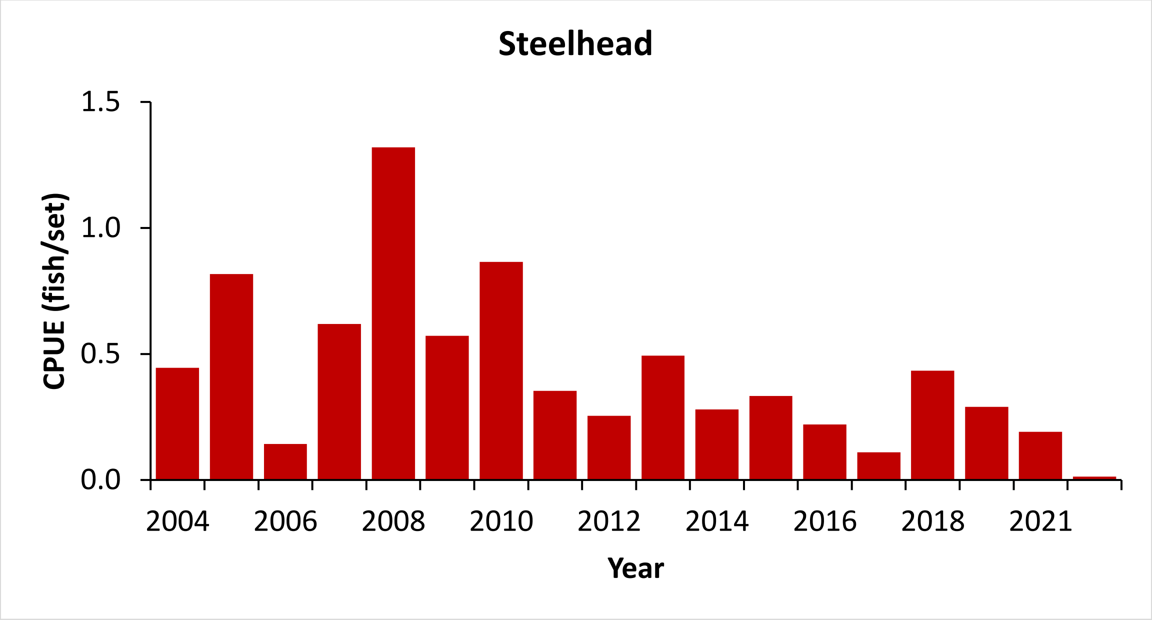

Figure 5-4
Abundance index (CPUE) of Juvenile steelhead captured by beach seine in the Russian River Estuary, 2004-2022. Samples from 84 to 303 seine sets conducted annually from May to October

5.5.1.3 Smolts

Abundance

As described above, Sonoma Water and CSG operate a series of DSMTs. For DSMTs operated by Sonoma Water, steelhead are most frequently encountered in Dry Creek, followed by Austin Creek, Dutch Bill Creek, and Mark West Creek. but few steelhead smolts are captured at any of the trap sites due to a large portion of the smolt outmigration that occurs before trap installation and the generally low trap efficiencies for steelhead smolts that is well-documented in the Russian River and elsewhere. As such, the season total catches of steelhead have been variable over the course of DSMT operation in the Russian River watershed.[419]

Sonoma Water and CSG attempted to overcome the problems created by a mismatch in the timing of trap operation relative to the steelhead smolt outmigration season in Dry Creek as follows. Beginning in 2015 with implementation of the CMP Sonoma Water and CSG developed an approach using backpack electrofishing and year-round, stationary PIT antenna monitoring to estimate smolts and/or juvenile steelhead leaving each LCS (including Dry Creek from 2015-2018). Raw detections at the antenna arrays are expanded based on site specific antenna efficiency to calculate an expanded count of steelhead detections. The expanded detection count is then divided by the number of juvenile steelhead PIT-tagged the previous fall to calculate a survival index. Finally, the survival index is multiplied by the pre-smolt abundance estimate from the previous fall to calculate a steelhead smolt estimate in each LCM stream (see Sonoma Water and CSG, 2022 for more information on methodology). In the absence of trapping and handling

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[419] J. Martini-Lamb and Manning, D.J. editors. 2020. *Op. cit.*

steelhead to determine which individuals are smolts, Sonoma Water and CSG rely on the timing of downstream movement out of their natal stream to classify individuals as potential smolts. Individual steelhead are classified as smolts if they were detected at a given LCS during the period from November 1 through June 30, annually.

Steelhead smolts estimates have varied widely (**Table 5-8**). In 2015 and 2016 the estimated number of emigrants from Dry Creek was very low (2,068 and 2,800, respectively) but markedly higher in 2017 (14,989). The period of operation of the Dry Creek antenna array in 2018 was significantly truncated due to a complete compromise of array integrity in late February. Consequently, the survival index significantly under-represents the true number emigrating from Dry Creek which is why no estimate for emigrants (smolts) was calculated for Dry Creek in the winter/spring of 2018/19.

TABLE 5-8
ESTIMATED SMOLT ABUNDANCE BASED ON PIT DETECTIONS FOR STEELHEAD IN DRY CREEK, 2015-2018

Year	Number PIT-tagged	Raw detections at mouth	Raw proportion emigrating	Antenna efficiency	Survival index	Fall pre-smolt abundance	Number of emigrants
2015-16[a]	1,671	61	0.04	0.56	0.07	31,718	2,068
2016-17	1,470	52	0.04	0.56	0.06	44,402	2,800
2017-18	1,668	141	0.08	0.29	0.30	50,661	14,989
2018-19[b]	1,145	50[c]	0.03	0.96[d]	0.05	29,759	N/A

NOTES:

[a] Source of data for 2015-2017: Sonoma Water and California Sea Grant. 2019. Implementation of California Coastal Salmonid Population Monitoring in the Russian River Watershed. Santa Rosa, CA. 72 pp. + appendices.

[b] Source of data for 2018: Sonoma Water and California Sea Grant. 2020. California Coastal Salmonid Population Monitoring in the Russian River Watershed: 2019. Santa Rosa, CA. 35 pp.

[c] The antenna at the mouth of Dry Creek was not operational after February 20, 2019. Using the proportion of steelhead emigrants detected at the Mill Creek antenna during the period of November 1, 2018 to February 20, 2019 (46%) the raw detections at Dry Creek was expanded from 23 to 50.

[d] Antenna efficiency at Dry Creek was calculated for the period of November 1, 2018 to February 20, 2019 and is likely an overestimate since the antenna was removed when river depth increased, the same conditions that would reduce antenna efficiency.

Compared to current LCS streams, Dry Creek has a much larger drainage area and is subject to backwatering from mainstem Russian River during high winter flows – both of which can affect antenna efficiency especially if steelhead are emigrating during high flow periods. When these high flow periods persist, an unknown number of steelhead emigrants can swim past the Dry Creek antenna array without ever being within the antenna detection field. At the U.S. Geological Survey gage station at the mouth of Dry Creek where the Dry Creek antenna array is located, the median water depth from 2015-2018 during the steelhead smolt emigration period (January-May) was 2.6 m deeper than the water depth of 0.6 m at the Dry Creek base flow of approximately 110 $ft^3 s^{-1}$. In 2015, 43 of the 91 days (47%) between January 1 and March 1 when the majority of steelhead emigration from Dry Creek occurred, it was >3.6 m deep at the antenna site as compared to the 0.6 m base flow water depth. This likely contributed to the questionably low estimate of emigrants from Dry Creek in 2016 and 2017 and the lack of estimate generated for emigrants in 2018.

In addition to the Dry Creek smolt estimate described above (Table 5-8), Sonoma Water and CSG use year-round, stationary PIT antenna monitoring to estimate the number of smolts and/or juvenile steelhead leaving the CMP LCS, including the Mill Creek sub-watershed (since 2017), and the Green Valley Creek, Dutch Bill Creek, and Willow Creek sub-watersheds (since 2019) (**Figure 5-5**).[420] The same methods for calculating a survival index and generating a population estimate for steelhead smolts is used as described for Dry Creek above.[421] Importantly, smolt estimates are only generated in streams and seasons where conditions allowed juvenile abundance estimates and PIT-tagging the previous fall. Since smolt estimates are based on pre-smolt estimates and subsequent detection of PIT tagged fish, none are available for Mill Creek or Willow Creek watersheds for the 2020-2021 season. Additionally, estimates in 2020/2021 season for Green Valley Creek watershed is from Purrington Creek only.

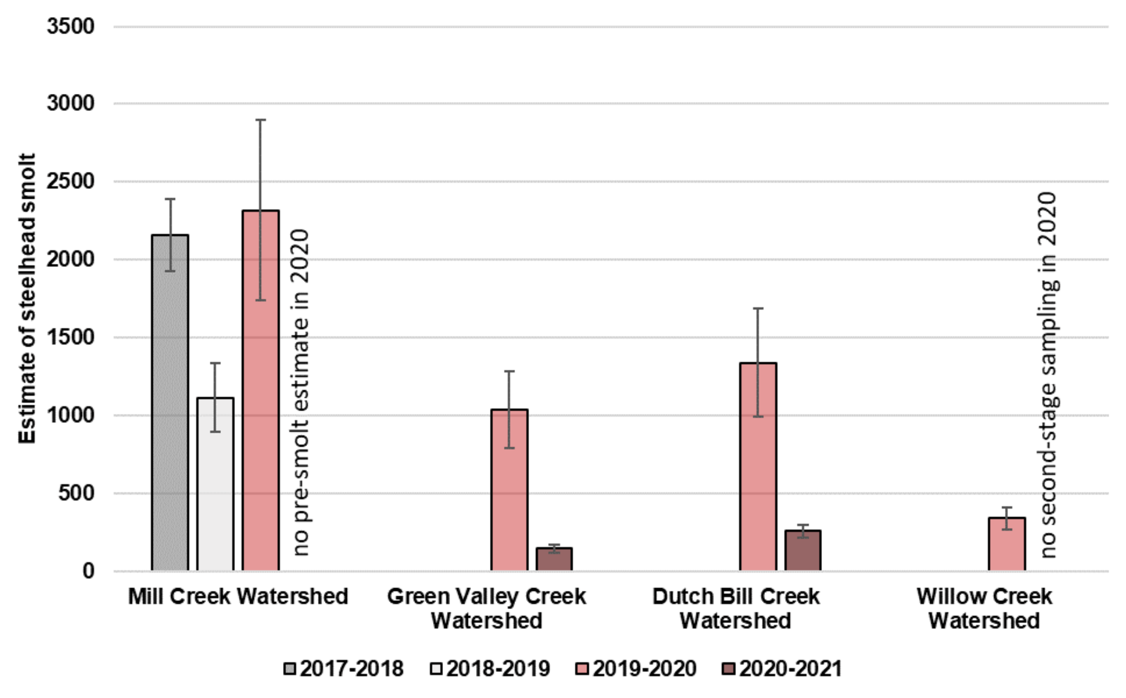

Figure 5-5
Smolt Estimates for steelhead from four Russian River watersheds
Error bars represent +/- 95% CI

The estimated number of steelhead emigrating from all LCSs ranged from 2,319 in Mill Creek (2019-2020) to 145 in Purrington Creek in the Green Valley watershed (2020-2021) (Figure 5-6). Due to low water conditions no second-stage sampling was conducted during the late summer of 2021, therefore, no steelhead smolt estimate for the 2021-2022 emigration season were generated. The documentation of straying of hatchery steelhead during these surveys is rare. Only one adipose-clipped steelhead smolt was encountered during these surveys. However, during

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[420] SCWA and California Sea Grant. 2022. Implementation of California Coastal Salmonid Population Monitoring in the Russian River Watershed. Santa Rosa, CA. 70 pp. + appendices.

[421] SCWA and California Sea Grant. 2022. Implementation of California Coastal Salmonid Population Monitoring in the Russian River Watershed. Santa Rosa, CA. 70 pp. + appendices.

spawning surveys a few hatchery adult steelhead are documented each year (See Section 5.5.1.1, *Adults*).

For each LCS, Sonoma Water and CSG detect some individuals emigrating from their natal stream more than one year after they were initially sampled. For juveniles tagged in the summer of 2020, Sonoma Water and CSG detected 9 steelhead from the Mill Creek watershed, 7 from the Dutch Bill Creek watershed, and 19 from the Green Valley Creek watershed emigrating from their natal streams between October 25, 2021 and March 31, 2022. While these individuals are of unknown hatch year, based on their size at tagging (average fork length 77.2 mm) they are likely 2+ steelhead at time of emigration. This life history strategy has been document in previous sampling seasons.[422]

Two-stage sampling of juvenile steelhead in the late summer has proven to be an effective method for generating steelhead smolt abundance estimates in the LCS. Additionally, the ability to use a stratum specific calibration ratio to calibrate first-stage snorkel counts when conditions are not suitable for electrofishing has provided means to calculate pre-smolt abundance estimates without exposing fish to unnecessary stress. Pre-smolt estimates peaked at a total of 33,111 for all LCS combined in 2019 to a low of 4,246 in 2021, which represents an 87% difference. Poor stream conditions observed in the summers of 2020 and 2021 (low dissolved oxygen, high water temperatures, and low water levels) are possible contributing factors to the observed decline. As expected, steelhead smolt abundance was considerably lower in the 2020-2021 season compared to the 2019-2020 season, due both to lower pre-smolt abundance and lower survival rates. While Sonoma Water and CSG were unable to calculate survival to smolt stage for the 2021-2022 cohort (no fish were PIT tagged), it is assumed based on the significant amount of stream drying observed and poor water quality in the remaining wetted sections that survival to this stage is extremely low. Detections of tagged steelhead has provided additional information on various life history strategies. While the exact age at emigration is unknown, based on size at tagging and date of emigration steelhead emigrating from their natal streams as likely age-1+ and age-2+ are common. While most emigrants are observed in the season immediately following the late summer sampling (assumed to be age-1+), Sonoma Water and CSG have observed between 3% to 10% of emigrants leaving their natal streams as age-2+, with an observed variation in the assumed age at return for adult steelhead between 2.5 and 5 years after emigrating.[423]

5.5.2 Coho Salmon

5.5.2.1 Adults

Abundance

In partnership with Sonoma Water, CSG has been closely monitoring the number of adult Coho Salmon returning to the Russian River watershed each year. The methods for counting and estimating the number of returning adult Coho Salmon has varied among years. Prior to the 2009/10 return winter, spawner surveys were the primary method used to indicate adult returns. From 2009/10 to 2011/12 additional methods including video monitoring and PIT detection

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[422] SCWA and California Sea Grant. 2022. *Op. cit.*

[423] SCWA and California Sea Grant. 2022. *Op. cit.*

systems were incorporated. Beginning in 2012/13, with the installation of the Duncans Mills PIT antenna array, PIT tag detection systems have been the primary method for indicating abundance.

PIT Antenna Detections

Detection data from PIT antenna arrays has been useful for indicating adult abundance. PIT antenna data has also allowed estimates of smolt abundance and survival leading to freshwater smolt production and adult returns. A significant portion (typically 15%, annually) of hatchery fish are tagged each year before they are released into the wild. In addition, a portion of natural-origin fish and untagged hatchery-origin fish captured at smolt traps are PIT-tagged as smolts during the smolt migration season each spring. PIT-tagged fish are then subject to detection at strategically located PIT antenna arrays in the watershed during smolt and adult migration periods. These data allow production measures from locations upstream of PIT antenna arrays that are useful in tracking abundance at spatial scales from the sub-watershed to watershed scale. A PIT antenna array located near the upstream end of the Russian River Estuary has been particularly important for developing expanded counts of adults returning to the Russian River watershed and PIT antenna arrays located at the mouth of four key LCS sub-watersheds (Willow, Dutch Bill, Green Valley, and Mill) have facilitated estimates of juvenile overwinter survival, smolt abundance and expanded counts of adults in these sub-basins. Data collected from these efforts are provided to the Broodstock Program for use in adaptively managing future hatchery releases.

Prior to 2009/10, documented returns of Coho Salmon adults to the Russian River were often fewer than 10 individuals (**Figure 5-6**). Between 2012/13 and 2021/22 when the Duncans Mills PIT antenna allowed expanded counts from antenna detections, annual hatchery Coho Salmon adult returns averaged 462 fish.[424] In winter 2017/18, adult returns were the highest of any year during this period with an estimated 763 hatchery fish returning while the number returning during the winter of 2020/21 was the second lowest, with an estimated 214 adults.

The winters of 2018/19 and 2019/20 were characterized by moderate rainfall with creeks opening in December prior to the usual peak of Coho spawning. Most fish were detected entering the watershed between late November and early December. Likely due to these favorable flow conditions, two of the highest return of Coho adults since starting CMP monitoring in 2013. This is in contrast to 2020/21 when flow conditions were not ideal and adult Coho returns were much lower, however there was a much higher proportion of three-year-old fish in Mill creek than in previous years (**Figure 5-7**).[425] In 2020/21 the first storms large enough to open creeks for spawning access did not occur until January and there was likely a reduction in spawning in these creeks as a result.

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[424] California Sea Grant. 2021. Coho Salmon and Steelhead Monitoring Report, Winter 2020/21. Windsor, CA.

[425] SCWA and California Sea Grant. 2022. *Op. cit.*

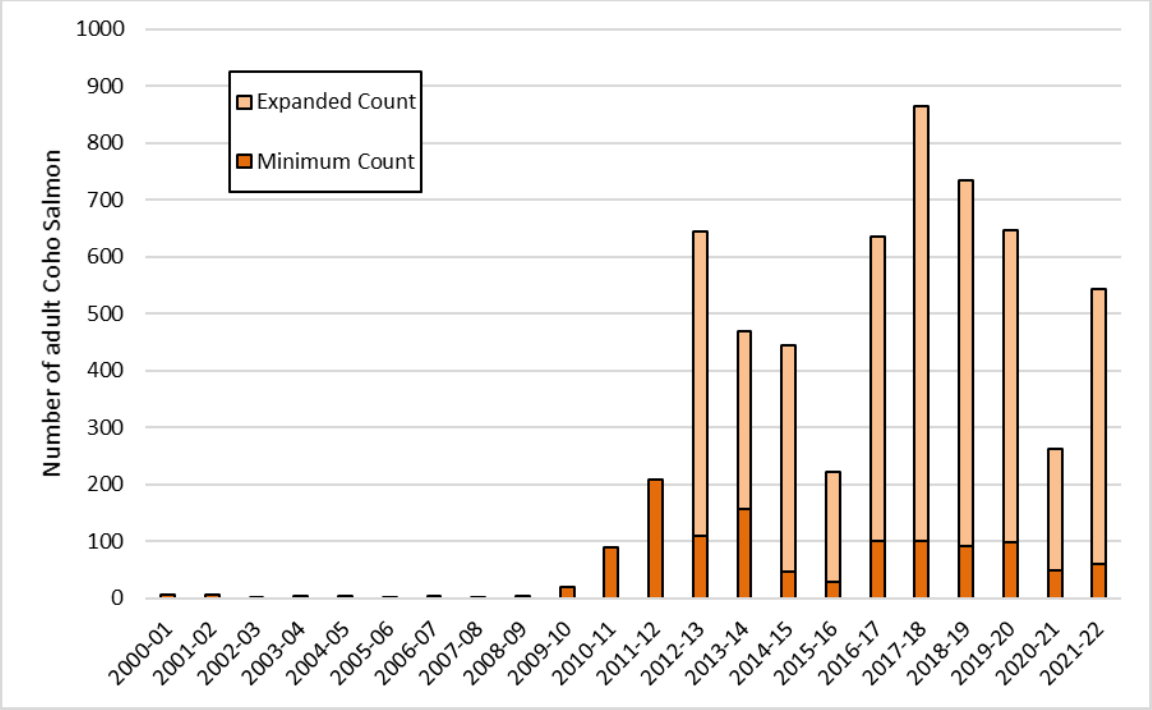
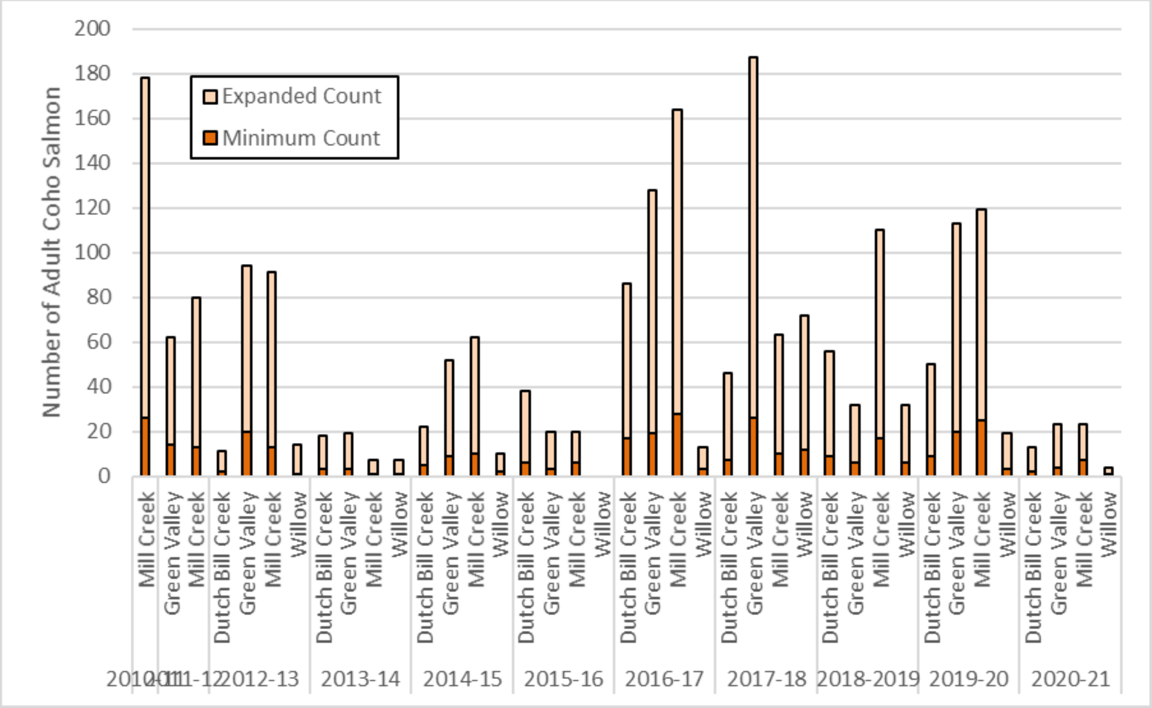


Figure 5-6
Adult Hatchery Coho Salmon Returns to the Russian River (expanded count)



Note: In recent years, PIT-tagging smolts at some DSMTs was initiated. Therefore, although the numbers are few, there were some natural-origin fish that returned in more recent years.

Figure 5-7
Abundance of hatchery-origin fish in Life Cycle Monitoring Tributaries by Return Year

Redds

Between the 2013/14 and 2020/21 spawner seasons basinwide estimates for Coho Salmon redds have fluctuated between a high of 180 redds in 2015/16 to a low of 85 in 2016/17, with an average of 125 redds per spawner season. Basinwide redd estimates have been relatively consistent since 2013/2014, with minor differences likely driven by variations in streamflow. The timing and magnitude of precipitation events can affect the spawning success and distribution of returning Coho Salmon. While increased streamflow can provide Coho adults access to larger amounts of instream spawning habitat, increasing redd establishment, elevated streamflow can also have deleterious effects. When large spikes in streamflow occur, gravel beds can mobilize, washing out salmon redds along with the gravel. Scour of this nature can be a significant source of egg loss.

In recent years, late and limited winter precipitation appears to have affected the spawning distribution of returning Coho Salmon. For example, over half of the observed Coho Salmon redds were found in Austin Creek (18/35) in 2020/21, whereas in the previous five winters the proportion of Coho Salmon redds observed in Austin Creek ranged from 0 to 7 percent. This is likely because Austin Creek is more accessible than most tributaries during low flow conditions because of its larger size. Additionally, very few salmonid redds were observed in both Green Valley and Willow as compared to Dutch Bill and Mill. Willow and Green Valley are lower gradient than Dutch Bill and Mill.[426] Coho Salmon spawner survey results are shown below in **Figure 5-8**.

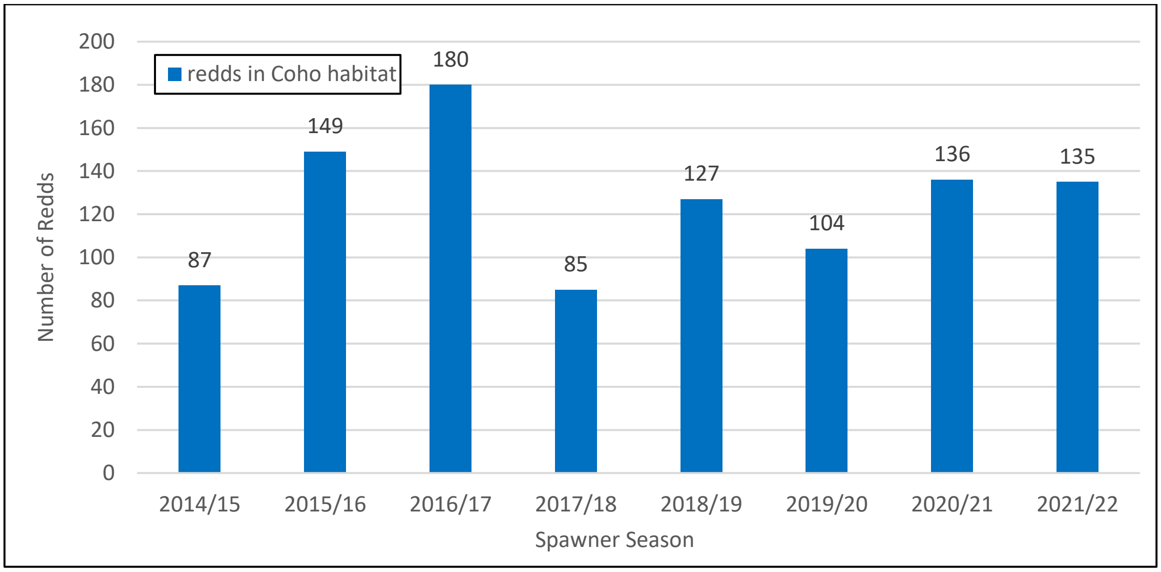


Figure 5-8
Basinwide estimates for Coho Salmon redds

Overall, the winter of 2020/21 posed new flow-related challenges to salmonids, particularly Coho Salmon. All salmonid runs within the Russian River have been impacted by exceptionally low streamflow during the summer dry season, as well as the impacts of dry spring conditions on the

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[426] California Sea Grant. 2021. *Op. cit.*

ability of smolts to emigrate. The impacts of low winter rainfall are also likely becoming more problematic for early life stages.[427,428] The low and late precipitation in winter of 2020/21 delayed the time that adult salmonids could access the spawning tributaries by approximately six weeks and reduced the number of streams fish could access during their spawning window. On a stream scale, Coho Salmon presence was reduced to approximately half of what was observed in the previous five years, and within streams it was likely even further reduced. Additionally, monitoring conducted by Sonoma Water and CSG has observed increased redd exposure from stream drying in multiple tributaries.

5.5.2.2 Juveniles and Smolts

Abundance

As part of the Broodstock Program, CSG also uses a series of DSMTs and PIT antenna arrays to estimate Coho Salmon smolt abundance, natural production, freshwater survival, migration timing, and freshwater growth. Coho Salmon smolt records from Sonoma Water and CSG DSMT operation are shown below in **Table 5-9** and **Table 5-10**.

The proportion of natural-origin smolts captured across all streams was 7.7 percent during the 2020 trap year (353 natural-origin smolts/5,129 total known-origin smolts captured) (Table 5-13). This proportion was slightly higher than the average proportion over the previous five years. However, the 353 natural-origin smolts captured was the second lowest number captured since 2013 and less than half the number captured in any year except for 2019. The low number of natural-origin fish captured may have been influenced by the traps not being fished for about a month in 2019; however, antenna detections indicate that most smolts were moved during the period of trap operation so it is likely not the only explanation. Importantly, summer 2019 Coho Salmon YOY counts in the broodstock streams were low which would translate into fewer natural-origin smolts during the 2020 downstream migrant season.[429]

In the four LCS, CSG uses a two-trap mark-recapture design is used to estimate the total number of Coho Salmon smolts emigrating from LCM streams during the trapping season during the time traps were operated.[430,431] An antenna array located immediately upstream of each smolt trap acts as an upstream “trap” where fish were “marked” (marked fish=all PIT-tag detections on antenna array). The smolt trap serves as a downstream trap where fish were recaptured. PIT-tagged fish detected at both the antenna array and captured in the trap were considered recaptures, and non-PIT-tagged fish and PIT-tagged fish only detected in the trap (but not the antenna) are considered unmarked fish.

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[427] Obedzinski, M., S. Nossaman Pierce, G. E. Horton, and M. J. Deitch. 2018. Effects of flow-related variables on oversummer survival of juvenile Coho salmon in intermittent streams. Transactions of the American Fisheries Society 147(3):588-605.

[428] Vander Vorste, R., M. Obedzinski, S. Nossaman Pierce, S. M. Carlson, and T. E. Grantham. 2020. Refuges and ecological traps: Extreme drought threatens persistence of an endangered fish in intermittent streams. Global Change Biology, 26:3834-3845.

TABLE 5-9
TOTAL NUMBER OF COHO SALMON CAPTURED IN CSG AND SONOMA WATER DOWNSTREAM MIGRANT TRAPS, YEARS 2005-2020

Tributary	Life Stage	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
CSG Traps																		
Willow Creek	Parr/YOY	-	-	-	-	-	-	-	0	0	0	7	0	0	27	2	2	4
	Smolt	-	-	-	-	-	185	2,908	1,987	823	1,939	201	2,681	3,678	1,276	368	2,546	1,690
Dutch Bill Creek	Parr/YOY	16	-	625	309	608	348	231	-	-	-	6,810	3,573	4,880	5,840	4,887	361	2,374
	Smolt	0	-	0	0	0	0	1	-	-	-	2	0	2	3	2	0	1
Green Valley Creek	Parr/YOY	24	314	58	43	0	4	329	515	530	0	10	10	30	63	8	202	134
	Smolt	-	-	-	-	-	-	-	864	3,405	916	707	2,028	1,729	3,486	457	1,023	1,624
Mill Creek	Parr/YOY	-	-	-	-	-	185	2,908	1,987	823	1,939	201	2,681	3,678	1,276	368	2,546	1,690
	Smolt	-	-	-	-	-	0	5	0	2	0	0	18	2	3	1	4	3
Sonoma Water DSMT																		
Dry Creek	Parr/YOY	-	-	-	-	0	2	18	35	1	13	0	0	0	6	784	*	78
	Smolt	-	-	-	-	3	1	83	117	19	69	49	14	37	104	110	*	55
Mainstem (Mirabel)	Parr/YOY	-	-	-	-	0	0	0	10	45	137	2	11	1	1	2	*	19
	Smolt	-	-	-	-	5	1	15	26	20	6	0	2	4	298	157	*	49
Mark West Creek	Parr/YOY	-	-	-	-	-	-	-	7	66	0	0	5	0	0	0	*	10
	Smolt	-	-	-	-	-	-	-	28	32	102	84	16	61	97	549	*	121
Austin Creek	Parr/YOY	-	-	-	-	-	-	14	372	38	4	35	130	5	48	32	*	75
	Smolt	-	-	-	-	-	-	0	37	12	399	9	35	27	996	28	*	171

NOTE:
‘-‘ indicates that no trap was in operation

SOURCE: CSG, 2020. California Sea Grant Coho Salmon and Steelhead Monitoring Report: Spring 2020. Windsor, CA.

TABLE 5-10
NUMBER AND PERCENT OF NATURAL-ORIGIN COHO SALMON SMOLTS CAPTURED ANNUALLY IN DOWNSTREAM MIGRANT TRAPS, YEARS 2005-2020

Year	Willow Creek			Dutch Bill Creek			Green Valley Creek			Mill Creek		
	Number Natural Origin	Total Captured (known origin)	Percent Natural Origin	Number Natural Origin	Total Captured (known origin)	Percent Natural Origin	Number Natural Origin	Total Captured (known origin)	Percent Natural Origin	Number Natural Origin	Total Captured (known origin)	Percent Natural Origin
2005	-	-	-	-	-	-	9	15	60.0	2	635	0.3
2006	-	-	-	-	-	-	-	-	-	1	648	0.2
2007	-	-	-	-	-	-	1	509	0.2	1	2,408	0.0
2008	-	-	-	-	-	-	0	299	0.0	1	4,760	0.0
2009	-	-	-	-	-	-	1	607	0.2	65	14,730	0.4
2010	-	-	-	1	185	0.5	0	245	0.0	9	5,051	0.2
2011	-	-	-	0	2,904	0.0	2	231	0.9	22	7,240	0.3
2012	0	863	0.0	35	1,987	1.8	-	-	-	154	4,781	3.2
2013	12	3,397	0.4	106	823	12.9	-	-	-	3	2,014	0.1
2014	331	914	36.2	262	1,930	13.6	-	-	-	168	1,440	11.7
2015	20	700	2.9	8	200	4.0	827	6,764	12.2	155	5,673	2.7
2016	430	2,020	21.3	85	2,666	3.2	231	3,570	6.5	24	2,425	1.0
2017	43	1,727	2.5	151	3,667	4.1	396	4,865	8.1	159	2,553	6.2
2018	663	3,484	19.0	40	1,260	3.2	529	5,831	9.1	39	1,270	3.1
2019	52	453	11.5	12	364	3.3	282	4,877	5.8	3	227	1.3
2020	92	1,018	9.0	216	1,707	12.7	10	359	2.8	35	1,527	2.3
Average	**183**	**1,620**	**11.4**	**83**	**1,608**	**5.4**	**191**	**2,348**	**8.8**	**53**	**3,586**	**2.1**

NOTE:
‘-‘ indicates that no trap was in operation

SOURCE: CSG, 2020. California Sea Grant Coho Salmon and Steelhead Monitoring Report: Spring 2020. Windsor, CA.

Coho smolt abundance estimates varied from a maximum of 18,207 in Mill Creek during the 2015 trapping season to a minimum of 621 in Mill Creek in the 2021 trapping season (**Table 5-11**). After 2019 when additional LCM streams were added to the CMP monitoring Green Valley Creek had the greatest number of Coho smolts compared to other streams (Table 5-11).

TABLE 5-11
COHO SALMON SMOLT ABUNDANCE ESTIMATES FOR MILL, GREEN VALLEY, DUTCH BILL, AND WILLOW CREEKS

Year	LCM Creak	Estimated Abundance
2019	Willow Creek	1,931
	Dutch Bill Creek	3,242
	Green Valley Creek	13,949
	Mill Creek	2,294
2020	Willow Creek	2,348
	Dutch Bill Creek	3,579
	Green Valley Creek	11,479
	Mill Creek	5,460
2021	Willow Creek	2,161
	Dutch Bill Creek	1,418
	Green Valley Creek	6,586
	Mill Creek	692
2022	Willow Creek	2,219
	Dutch Bill Creek	2,257
	Green Valley Creek	5,457
	Mill Creek	5,996

SOURCE: California Sea Grant Coho Salmon and Steelhead Spring Monitoring Reports: Windsor, CA.

The cohort of smolts and juveniles in 2018 was small which may have led to a smaller return of spawners in recent years. In recent survey years, CSG has been able to detect evidence of Coho returning to streams other than their natal stream, and this pattern seemed to increase during seasons with less favorable flow conditions for spawning. In 2019/20 CSG found evidence that fidelity in pre-smolts and smolts was highest in Dutch Bill and Dry Creek and lower in Green Valley and Mill Creeks. This could be related to habitat quality in those creeks, or possibly differences in imprinting. There is also evidence that when flow conditions are low many fish returned to Dry Creek where flows are artificially maintained at high levels even in low flow years.

Estuary Residence

Since seining was initiated in 2004, Coho Salmon capture rates have fluctuated. No Coho were captured during the 2004 and 2005 survey years and only one fish captured in 2006 (**Figure 5-9**). However, since 2006 a minimum of 7 Coho have been captured by seine within the Estuary each year. The single highest CPUE for Coho occurred in 2011 at 0.87 fish/set. Since 2011 capture rates have remained relatively consistent, averaging 0.18 fish/set from 2012-2022. Coho captures during Estuary seining occur most frequently in May, but Coho have been documented in other months at lower frequencies.

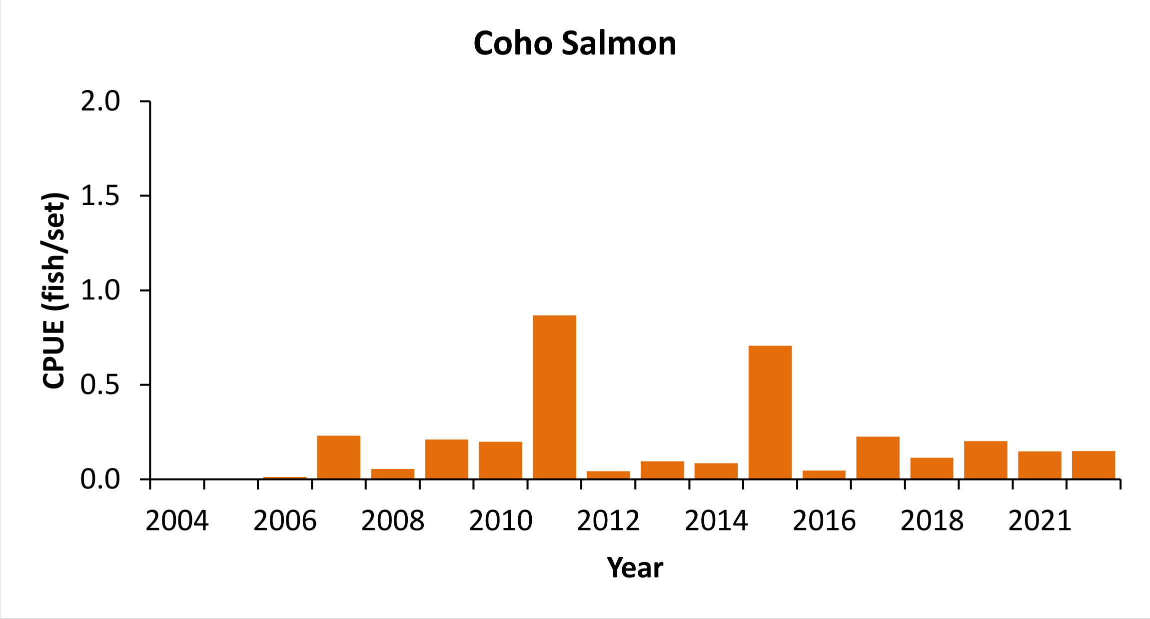

Figure 5-9
Abundance index (CPUE) of Juvenile Coho salmon captured by beach seine in the Russian River Estuary, 2004-2022. Samples from 84 to 303 seine sets conducted annually from May to October

5.5.3 Chinook Salmon

5.5.3.1 Adults

Abundance

Except for 2014 and 2015 when construction of a new fish ladder and fish screens at Mirabel prevented inflation of the dam, Sonoma Water has been operating video cameras at the Mirabel dam since 2000 to count the number of adult Chinook Salmon passing the Mirabel inflatable dam located at rkm 38.6 (**Table 5-12**).

TABLE 5-12
ADULT CHINOOK SALMON RETURN ESTIMATED DERIVED FROM MIRABEL VIDEO COUNTS

Return Year	Video Count
2000	1,445
2001	1,383
2002	5,474
2003	6,103
2004	4,788
2005	2,607
2006*	3,407
2007	2,021
2008	1,129
2009	1,800
2010	2,502
2011	3,173
2012	6,730
2013	3152
2014**	-
2015**	-
2016***	1062
2017	2093
2018	1219
2019	922
2020	625
2021***	-
2022	1,180

NOTE:

* Video cameras were reinstalled and operated from 4/1-6/27/2007 but no Chinook were observed.

** Video cameras not operated in 2014 and 2015 because the site was under construction in order to construct the new fish screens and ladder. Count not obtained in 2021 because early season storm precluded camera operation beyond October 23.

*** In 2016 and 2021 the cameras were removed early in the migration season due to high stream flows.

SOURCE: Sonoma Water, 2022. G. Horton and A. Pecharich personal communication. March 10, 2022 and unpublished data.

Individuals are counted as moving upstream once they exit the upstream end of the camera's view. For each adult salmonid observed, the reviewer recorded the species, date, and time of upstream passage. During periods of low visibility, it was not always possible to identify fish to species although identification as an adult salmonid was usually possible. Adult salmonids that could not be identified to species were lumped into a general category called "unknown salmonid." Unknown salmonids are then partitioned into species by taking the proportion of each species positively identified in the ladder on a given day and multiplying the number of unknown salmonids on that same day by these proportions. On days when no salmonids could be identified to species, an average proportion from adjacent days was used to assign species for the unidentified salmonids on that day.

The Mirabel video system relies on flow through the fish ladders thus it can only operate when Sonoma Water's rubber dam is inflated. In 2016 and 2021 the dam was deflated before the typical historical end date of the adult Chinook migration season. Adult Chinook counts ranged from 625 adults in 2020 to 6,730 in 2012 (Table 5-12). Average annual counts since 2000 are approximately 2,641 adults.

5.5.3.2 Smolts

Abundance

Total number of Chinook Salmon captured in CSG and Sonoma Water downstream migrant traps for years 2005-2020 is presented in **Table 5-13**. Trends in CSG traps (Dutch Bill Creek, Green Valley Creek, and Mill Creek) show decreases in trap counts from the late 2000s to present with relatively low count for all years. Trends in Sonoma Water traps (Dry Creek and mainstem Russian at Mirabel) show a decreasing but highly variable trend in Dry Creek and relatively stable trend in the mainstem at Mirabel (years 2019 and 2020 were slightly higher than the average for the period of record) with much higher relative trap counts. Note that in 2014 and 2015 the Mirabel dam was under construction and the mainstem Russian River trap was operated further upstream (river km 69.82).

Estuary Residence

The 2007 and 2008 surveys exhibited the highest capture rates since of Chinook Salmon since seining was initiated in 2004, with fish/set capture rates of 4.53 and 5.18, respectively (**Figure 5-10**). Since 2008, Chinook Salmon abundance in the Estuary has remained relatively consistent, averaging 0.85 fish/set between 2009 and 2022.

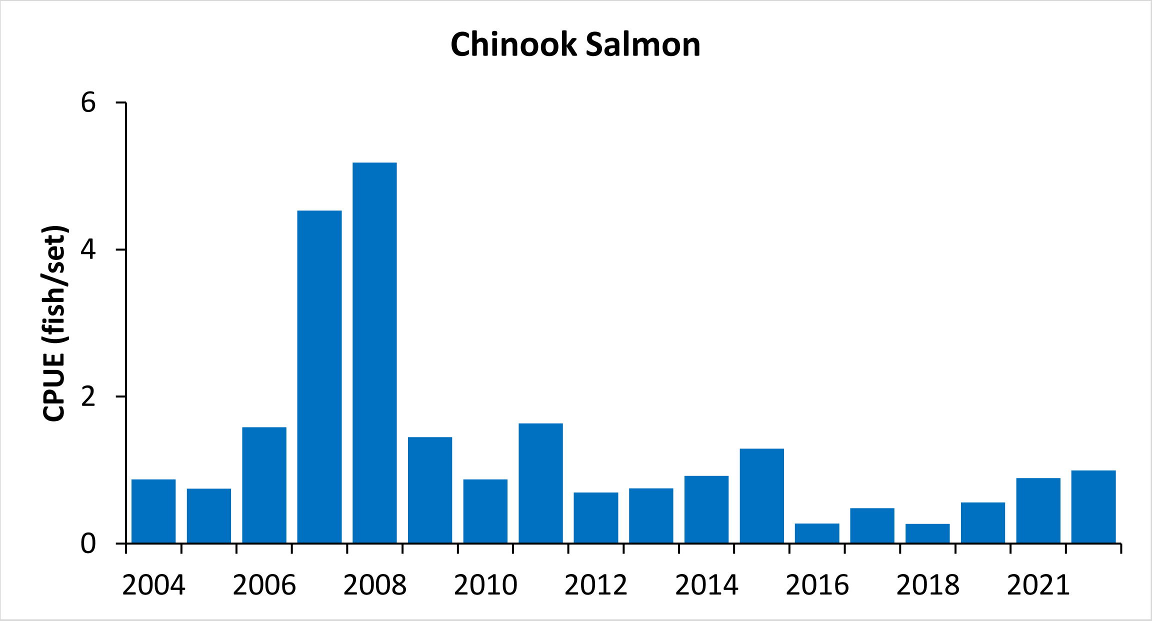

Figure 5-10
Abundance index (CPUE) of juvenile Chinook Salmon captured by beach seine in the Russian River Estuary, 2004-2022. Samples from 84 to 303 seine sets conducted annually from May to October

Table 5-13
Total Number of Chinook Salmon captured in CSG and Sonoma Water Downstream migrant Traps, years 2005-2020

Tributary	Life Stage	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
CSG Traps																		
Dutch Bill Creek	Smolt	-	-	-	-	-	4	34	13	0	10	0	15	2	8	6	17	10
Green Valley Creek	Smolt	925	-	226	40	0	14	16	-	-	-	0	0	0	0	0	0	102
Mill Creek	Smolt	70	128	2	31	1	1	0	11	0	22	0	0	1	1	0	0	17
Sonoma Water Traps[1]																		
Dry Creek	Smolt	-	-	--	200,415	84,785	225,392	117,930	105,211	172,444	267	27,053	64,385	37,260	43,250	17,665	-	91,338
Mainstem (Mirabel)	Smolt	-	-	-	1,324	2,286	13,540	2,287	6,297	5,527	267	328	632	2,521	2,621	3,687	3,837	3,473

NOTE: The numbers presented for Sonoma Water traps (Dry Creek and Mainstem (Mirabel)) are population estimates and for CSG traps are minimum counts.

'-' indicates that no trap was in operation

SOURCE: CSG, 2020. California Sea Grant Coho Salmon and Steelhead Monitoring Report: Spring 2020. Windsor, CA.

SECTION 6

Effects of the Proposed Action

This effects section includes an analysis of both salmonid habitats, including primary constituent elements (PCEs) of critical habitat, likely to be affected by the Proposed Action, as well as an analysis of the effects to species, including an examination of the extent to which individual fish are exposed to habitat changes and what their response is expected to be to such changes.

The effects analysis relies on data and/or modeling efforts specific to the Russian River and the action area when such information is available. Where data specific to the Russian River watershed and/or action area are unavailable, information from other nearby river systems and more general information regarding aquatic habitat and salmonid responses to environmental perturbations is utilized. This information is overlaid with the Proposed Action to produce reasoned conclusions regarding likely effects of the Proposed Action on critical habitat and listed salmonids in the action area when considered along with the baseline. This section and the analysis is organized around major project elements, which are summarized in **Table 6-1** below.

In general, direct effects are those which physically contact the species being analyzed, such as physical damage to an individual as in the case of barotraumas, entrainment, or the complete physical loss of a spawning or foraging habitat, a blocked migration corridor, or harassment of an animal species to the point where it abandons part of its normal range. Indirect effects would include ecosystem type changes that primarily affect food web dynamics or habitat suitability as would occur with decreased suitability of foraging habitat, temporary noise or physical disturbance that results in avoidance behavior, and the reduced food-web value of foraging habitat as the result of the introduction of non-native invasive species.

Potential direct and indirect effects from the Proposed Action are discussed by the type of ecological effect expected and the activity causing the potential effect below. Additionally, because the entirety of the in-water construction work will occur in areas designated as EFH under the Magnuson-Stevens Fishery Conservation and Management Act, the effects of the Proposed Action analyzed in the following sections are discussed as they relate to impacts to such habitat.

TABLE 6-1
SUMMARY OF PROJECT ELEMENTS INCLUDED IN THE PROPOSED ACTION, STATUS, AND EFFECT MECHANISM

Proposed Action Project Element	Summary Description	Effect Mechanisms
Reservoir Flood Control Operations at Coyote Valley Dam (CVD) and Warm Springs Dam (WSD)	USACE is proposing ongoing (modified) flood control operations associated with *Planned Major Deviations* to the 1986 Lake Mendocino WCM for WY 2021 through WY 2026, pending updates to the WCM, and application of forecast-informed reservoir operations (FIRO) procedures at CVD. Application of FIRO procedures will continue after the WCM has been updated. USACE is also proposing ongoing flood control operations at WSD consistent with the Lake Sonoma WCM, with future proposed modifications associated with application of FIRO procedures, which are currently in development.	Water temperature Adult migration (migratory cues) Turbidity Streambed scour Bank erosion
Reservoir Water Supply Operations at CVD and WSD	Sonoma Water proposes an interim, seven-year change to its water-right permits in order to modify the hydrologic index to reflect conditions in the Russian River watershed as opposed to the current Decision 1610 index located in the Eel River watershed, and implement changes to Decision 1610 minimum flows consistent with the *2008 Biological Opinion* that calls for adjustments to the minimum flows for Normal and Dry hydrologic conditions, pending completion of permanent changes to Sonoma Water's water rights permits (see Fish Habitat Flows and Water Rights Project). Interim and permanent changes to Sonoma Water's water rights permits are intended to address current uncertainties associated with changes in operations of PG&E's PVP and its impact on water supply reliability in Lake Mendocino and the Russian River watershed.	Flow Habitat suitability (adult passage and spawning, outmigration, rearing) Water quality Turbidity (juvenile growth, juvenile/egg survival)
Russian River Estuary Management	Sonoma Water is proposing modified management of the Russian River Estuary with the objectives of enhancing salmonid habitat in the Estuary while minimizing flood risk to riverfront properties adjacent to the Estuary.	Habitat suitability (juvenile rearing and adult immigration)
Channel Maintenance on portions of the mainstem Russian River and Dry Creek	Sonoma Water and the MCRRFCD propose limited channel maintenance on portions of the mainstem Russian River and Dry Creek, specifically maintenance of facilities associated with CVD and WSD operations.	Temporary, construction-related disturbance Habitat loss
Central Sonoma Watershed Project flood control facilities operations	Sonoma Water proposes ongoing passive operations of Central Sonoma Watershed Project flood control facilities, including recently constructed bypass pipe at the Santa Rosa Creek diversion structure.	Entrainment
Coyote Valley Fish Facility (CVFF) and Don Clausen Fish Hatchery (DCFH) Facilities Maintenance	USACE proposes ongoing maintenance of facilities at CVFF and DCFH. However, hatchery management activities will be managed consistent with HGMPs, each with their own, separate FESA coverage; therefore, management is not included as part of this Proposed Action.	Temporary, construction-related disturbance
Dry Creek Habitat Enhancements	Sonoma Water and USACE propose ongoing monitoring and maintenance of Dry Creek enhancement projects and new enhancement actions that are currently in the planning phase.	Temporary, construction-related disturbance Long-term enhancement of rearing habitat
Physical and Biological Monitoring (Russian River watershed)	Sonoma Water and USACE propose modified physical and biological monitoring in the Russian River watershed associated with current and proposed monitoring needs.	Fish capture and handling Survival/Predation Studies

6.1 Flood Control Operations

As described in Section 3, all flood control releases from Lake Mendocino and Lake Sonoma are constrained by the need to reduce flood risk downstream within the Russian River watershed. During periods of high rainfall-runoff, storage increases at each lake. If within the flood control pool, and conditions downstream permit, water is required to be released from both reservoirs to restore storage space for the next event. Within the FIRO flood control pool, weather forecasts can enable a decision to continue to retain water and/or influence the rate of flood control release required to sustain flood risk management obligations. In this FIRO flood control pool, ramping rates can be considered while formulating a decision based on FIRO principles. For all flood control releases above the FIRO flood control pool, USACE will accommodate desired ramping rates to the extent possible without impacting flood risk management obligations.

Flood control operations at CVD and WSD include both non-discretionary and discretionary federal actions. Non-discretionary actions are those activities that are required to maintain Civil Works structures so that they continue to serve their Congressionally authorized purposes and are inherent in the authority to construct them. Non-discretionary federal actions at CVD and WSD include dam security and enforcement, dam safety inspections, implementation of the WCM (not including discretionary deviations to the WCM with application of FIRO procedures), annual pre-flood inspections, and periodic five-year inspections. Discretionary actions at CVD and WSD include deviations to the WCM with application of FIRO procedures. USACE has also proposed discretionary (voluntary) conservation measures to avoid and minimize potential adverse effects at CVD and WSD, which include minimum flows and ramping rates associated with annual pre-flood inspections and periodic five-year inspections (non-discretionary activities) (see Section 3.10, *Conservation Measures*).

A description of non-discretionary and discretionary actions at CVD and WSD, including rationale for determinations, is provided in Appendix A, Non-Discretionary and Discretionary Federal Actions at Coyote Valley Dam and Warm Springs Dam.

6.1.1 Coyote Valley Dam

USACE is proposing ongoing (modified) flood control operations associated with the Planned Major Deviation to the 1986 Lake Mendocino WCM for WY 2021 through WY 2026 with application of FIRO procedures at CVD. As noted in the time frame for the Planned Major Deviation (WY 2021 to 2026), the Proposed Action would be a continuation of operations from current (2021 to present under Baseline) into the future (Proposed Action). Beyond 2026, it is expected that the WCM would be updated to reflect flood control operations consistent with current proposed operations (Planned Major Deviation), including application of FIRO procedures.

CVD flood control operations include both water storage and water releases, which have the potential to increase cold water pool volume and associated water temperatures of releases downstream of the dam, change the timing and magnitude of high flows, increase turbidity, scour the streambed, and erode banks.

These operational mechanisms have the potential to affect Chinook Salmon migration and spawning habitat from changes in flows and water temperatures, and streambed scour and bank erosion; and potential Chinook and steelhead spawning and rearing habitat from the release of turbid waters.

Voluntary conservation measures are being proposed for non-discretionary federal activities associated with operation of CVD and WSD to include incremental ramping of flows to minimize the potential to create intermittent flow and/or dewatered conditions in rearing habitat used by both Chinook Salmon and steelhead fry and juveniles during the winter and spring. Down ramping of flows during pre-flood inspections and maintenance activities would also minimize the potential for dewatered channel and/or adverse water quality conditions, adversely affecting rearing habitat for juvenile steelhead.

6.1.1.1 Water Temperature

Habitat Effects

USACE is proposing ongoing (modified) flood control operations associated with Planned Major Deviation to the 1986 Lake Mendocino WCM for WY 2021 through WY 2026 and application of FIRO procedures. The Deviation with application of FIRO allows for a flexible water management approach that uses data from watershed monitoring and improved weather forecasting to help reservoir operators selectively retain or release water from reservoirs for increased resilience to droughts and floods, including more effective cold water pool management.

As part of the FIRO preliminary viability assessment (PVA) conducted for Lake Mendocino, NMFS recommended that water quality in the reservoir be evaluated in terms of sediment load and temperature stratification as a component of further evaluation of water availability. In addition, NMFS recommended evaluating the ability to maintain a cold-water pool and release cooler water in late summer for salmonid migration.[432]

The FIRO steering committee addressed this PVA recommendation by modeling scenarios to evaluate how water temperature conditions in the Lake Mendocino cold water pool might influence the upper Russian River cold water tailrace (zone or reach) below the reservoir, and further downstream. To answer this question, the effects of different reservoir storage level increases (scenarios associated with application of FIRO procedures) were analyzed to gain a better understanding of reservoir operation effects on cold water pool storage in Lake Mendocino and associated water temperatures in the upper Russian River mainstem during the juvenile steelhead summer rearing season and the adult Chinook Salmon fall migration period.

NMFS has monitored upper Russian River stream temperatures and water temperature at different depths in Lake Mendocino during summer and fall since 2015. The committee focused on observed data from two water years with dry (2015) and wet (2019) conditions. Based on these data, the committee developed a machine learning modeling approach to estimate stream and

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[432] Jasperse et al., 2020. *Op. cit.*

reservoir water temperatures that influence the quality of salmonid habitat within the upper Russian River.

In general, temperatures in the cold-water zone of the reservoir and upper Russian River tend to be lower for the scenarios with higher reservoir storage levels during the warm summer and early fall months (see **Figures 6-1** through **6-8**). Conversely, temperatures in the cold-water zone of the reservoir and upper Russian River tend to be higher for the scenarios with lower reservoir storage levels during this same dry-season period.

Figures 6-1 and 6-2 depict mean daily Lake Mendocino water temperature at different depths for 2015 and 2019, respectively. Figures 6-3 and 6-4 depict Lake Mendocino storage for different scenarios modeled for 2015 and 2019, respectively.

Figures 6-5 through 6-8 depict results for the 2015 and 2019 scenarios. In general, temperatures at the cold-water zone of the reservoir and at several locations in Upper Russian River[433] tend to be lower for the scenarios with higher reservoir storage levels (purple and blue solid lines). Conversely, the temperatures at the cold-water zone of the reservoir and Upper Russian River tend to be higher for the scenarios with lower reservoir storage levels (dark red and red solid lines).

Implementation of FIRO procedures in 2019 and 2020 resulted in conserved storage of approximately 11,175 acre-feet of water volume, an approximate 19 percent increase in storage available for releases later in the year compared to operations without the Deviation and FIRO procedures; demonstrating the water storage benefits identified above under the model scenarios.

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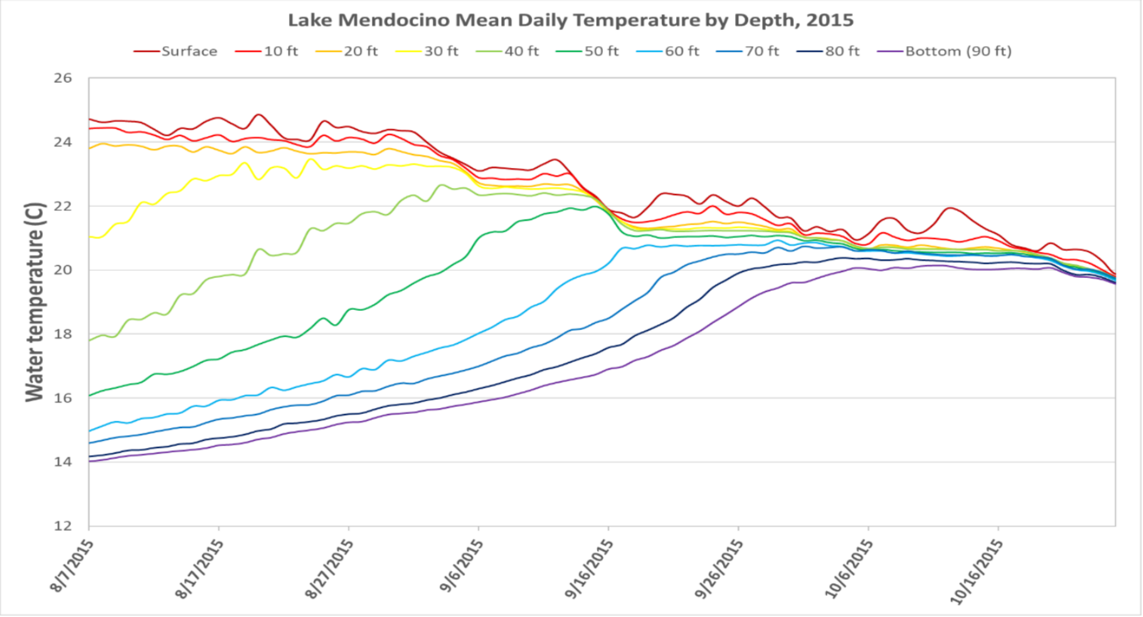
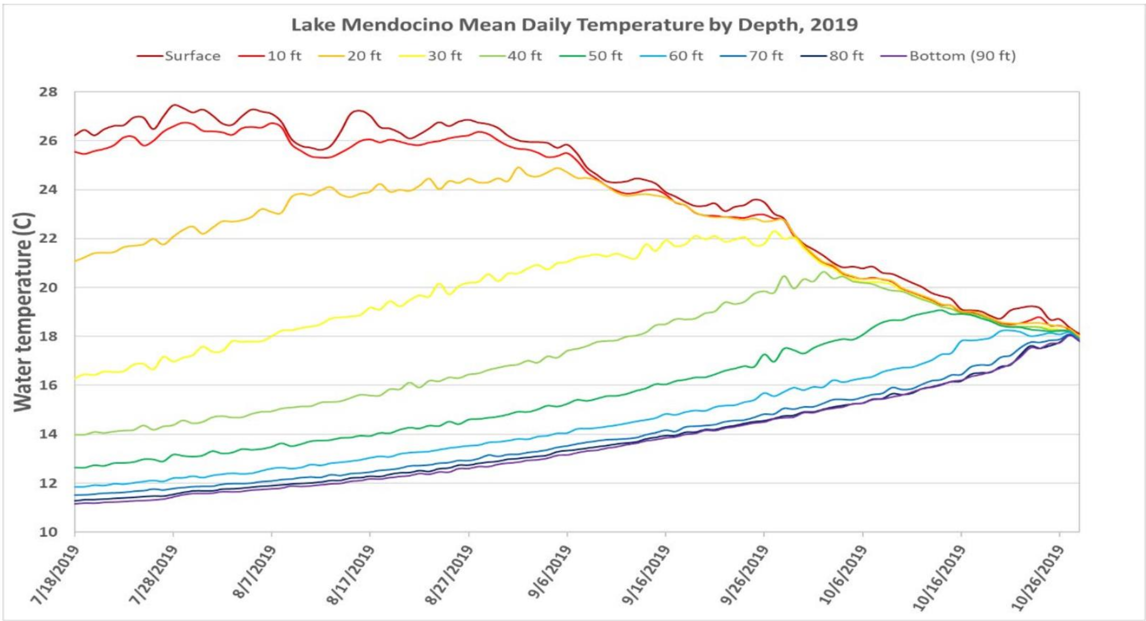
[433] Scenarios for the Upper Russian River water temperatures include model nodes at: a) MRC (Russian River below East and West folks), b) Burke Hill (Russian River below East and West Forks and above USGS gage at Hopland), c) USGS gage at Hopland, d) Old Hopland (Russian River below USGS gage at Hopland) , and e) Bradford (Russian River below Old Hopland and above Cloverdale).

See Jasperse et al., 2020, Figure 3. *Op. cit.*



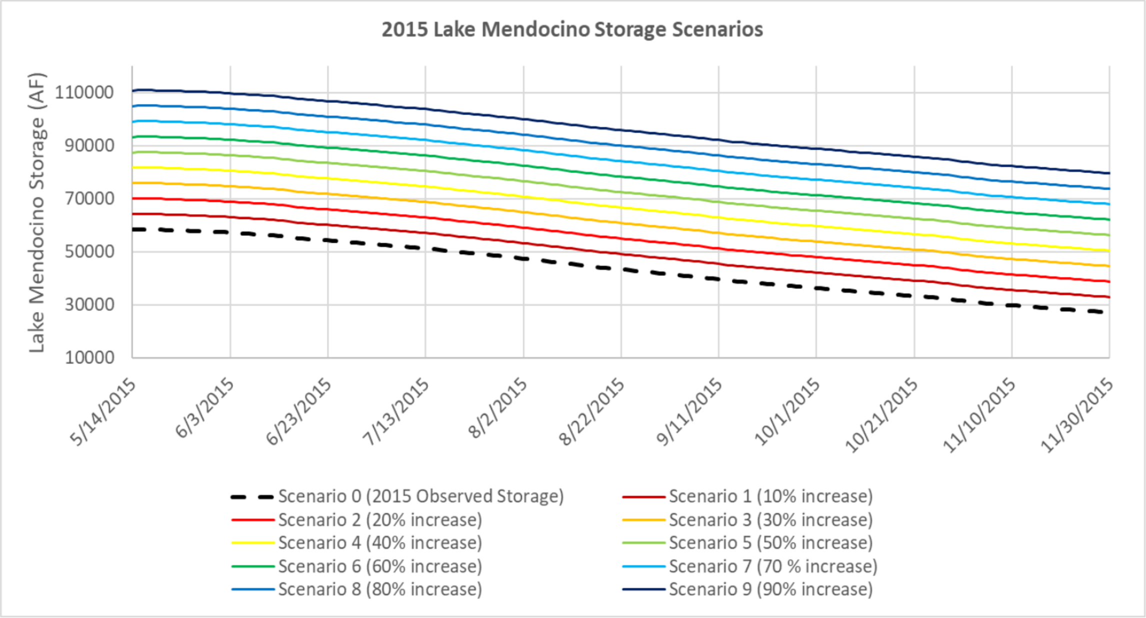
SOURCE: Jasperse et al., 2020, Appendix H

Figure 6-1
Daily Lake Mendocino Water Temperature at Different Depths, 2015.



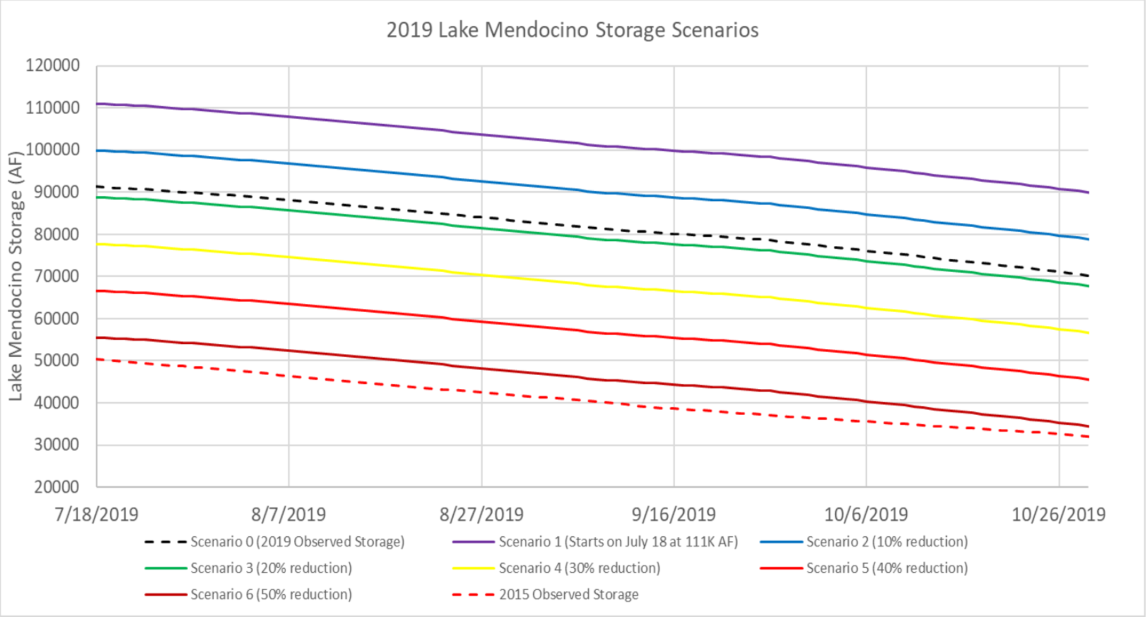
SOURCE: Jasperse et al., 2020, Appendix H

Figure 6-2
Daily Lake Mendocino Water Temperature at Different Depths, 2019.



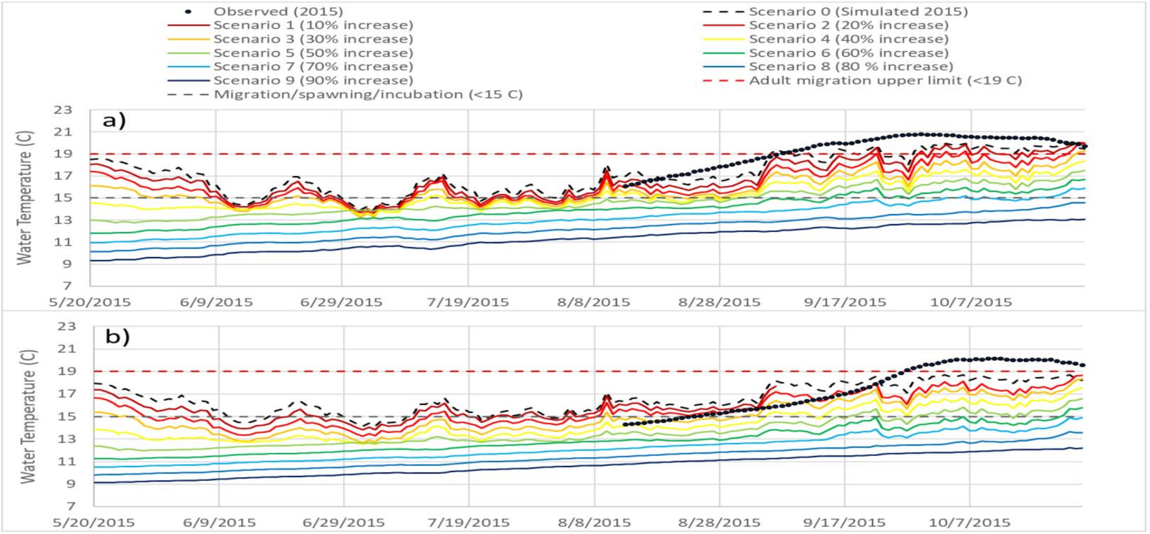
SOURCE: Jasperse et al., 2020, Appendix H

Figure 6-3
2015 Lake Mendocino Storage Scenarios.



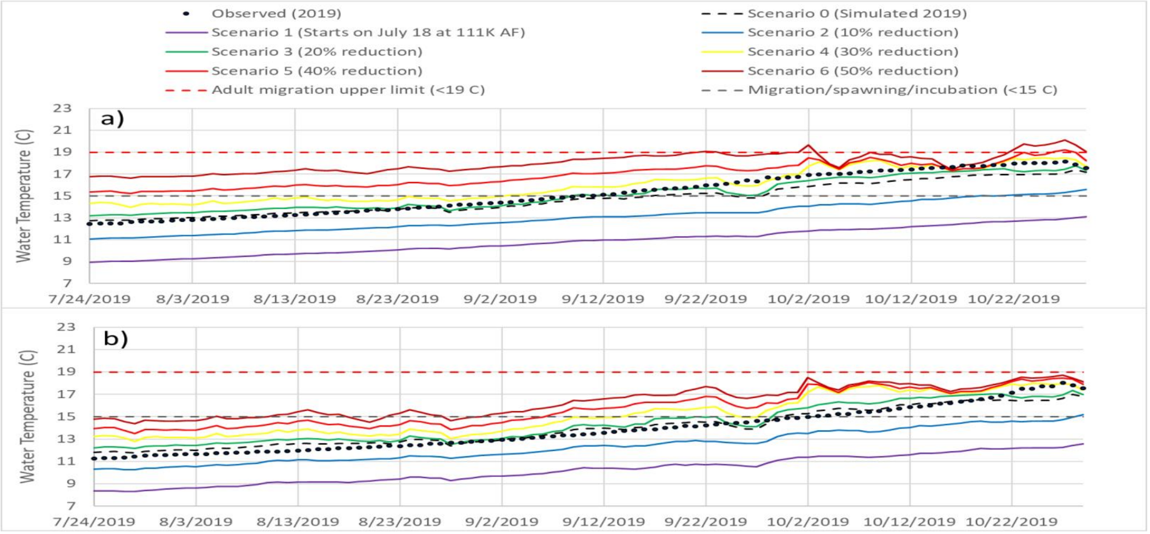
SOURCE: Jasperse et al., 2020, Appendix H

Figure 6-4
2019 Lake Mendocino Storage Scenarios.



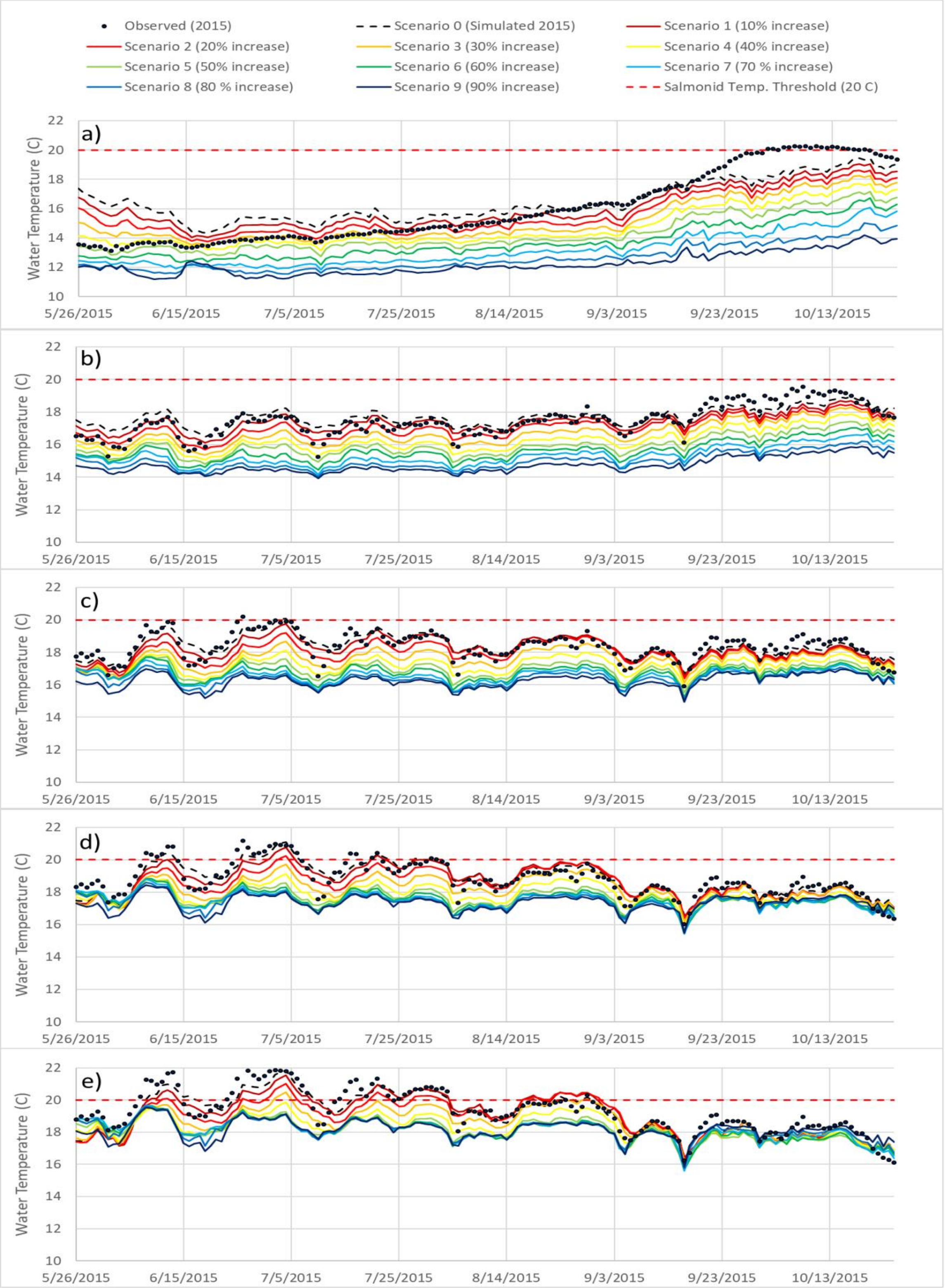
SOURCE: Jasperse et al., 2020, Appendix H

Figure 6-5
Scenarios for the 2015 Lake Mendocino water temperatures at depths: a) 40 feet to 80 feet average, and b) bottom.



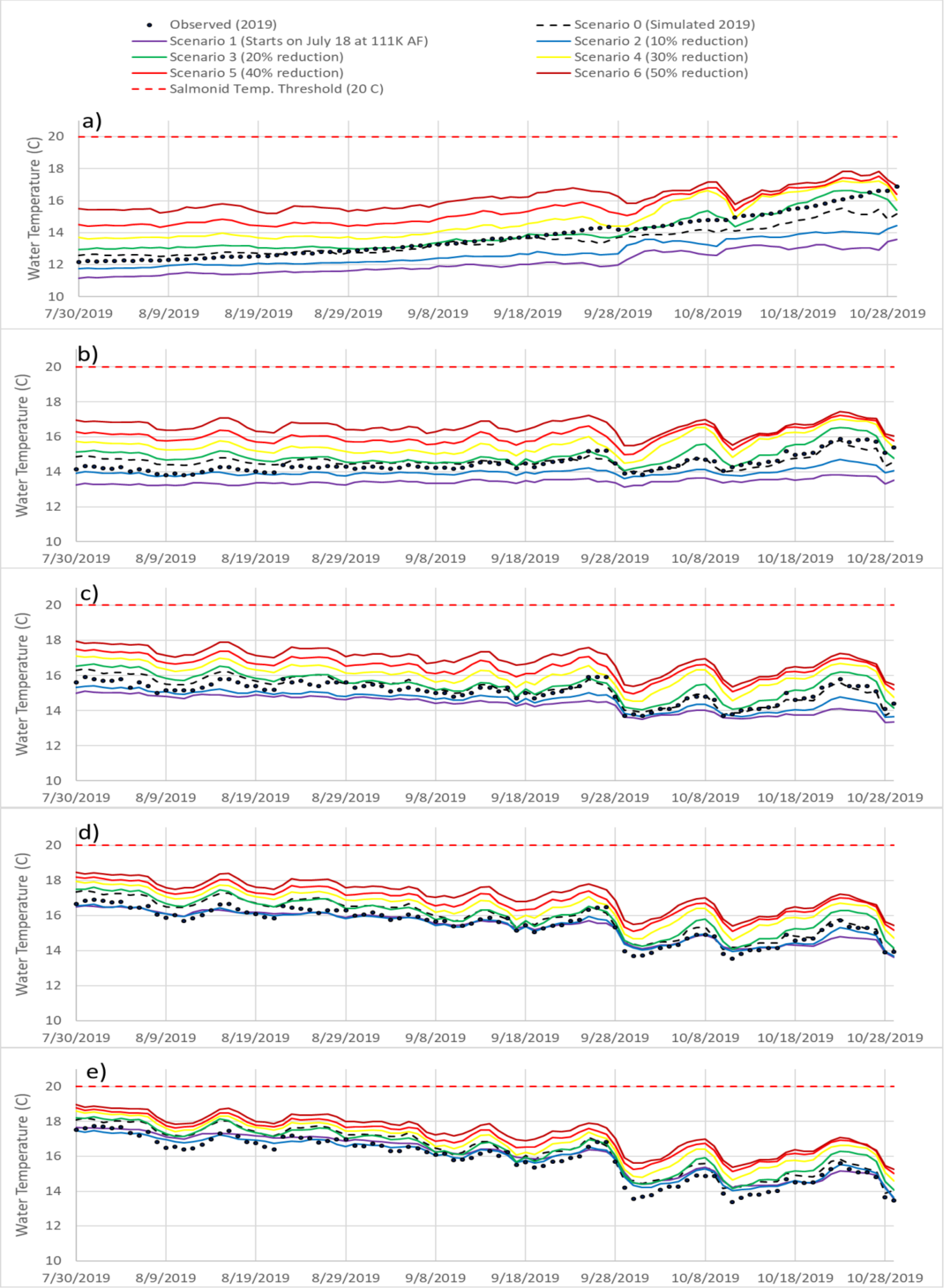
SOURCE: Jasperse et al., 2020, Appendix H

Figure 6-6
Scenarios for the 2019 Lake Mendocino water temperatures at depths: a) 40 feet to 80 feet average, and b) bottom.



SOURCE: Jasperse et al., 2020, Appendix H

Figure 6-7
Scenarios for the 2015 Upper Russian River water temperatures at:
a) MRC, b) Burke Hill, c) USGS Hopland, d) Old Hopland, and e) Bradford.



SOURCE: Jasperse et al., 2020, Appendix H

Figure 6-8
Scenarios for the 2019 Upper Russian River water temperatures at:
a) MRC, b) Burke Hill, c) USGS Hopland, d) Old Hopland, and e) Bradford.

Species Effects

Modeling results demonstrate the benefits of higher reservoir storage levels and cold water pool volume associated with the Deviation with FIRO procedures to maintain cooler water temperatures during the juvenile steelhead summer rearing season through the fall adult Chinook Salmon migration period, which would also encompass later timing of peak periods when Coho Salmon may be using the mainstem Russian River during migrations to and from tributary habitat (albeit in low numbers due to very few Coho Salmon using the Russian River tributaries above Maacama Creek) (see Section 5.2, *Central California Coho Salmon ESU*).[434]

Water temperature-related habitat conditions for steelhead, Chinook Salmon, and, to a lesser extent, Coho Salmon, would be managed generally within suitable ranges, with temperatures generally below thresholds for Chinook Salmon.[435] Beyond 2026, it is expected that the WCM would be updated to reflect flood control operations consistent with current proposed operations (Deviation), including application of FIRO procedures, which would result in similar (if not the same) effects to those under the Deviation.

Additional discussion on water temperature-related effects for the middle and lower Russian River and Dry Creek is provided below under Section 6.2, *Water Supply Operations*.

6.1.1.2 Adult Migration Cues

Habitat Effects

There is some uncertainty as to whether current proposed operations (Deviation) with application of FIRO procedures, may negatively affect migration cues that trigger upstream movement of Chinook Salmon and to a lesser extent steelhead (due to run timing occurring later in the year) and Coho Salmon (due to later run timing and limited distribution in the upper Russian River) (see Section 5 for species migration timing and distribution) through reductions in the frequency of flood control releases during the fall months. One potential unintended consequence of FIRO is that there may be fewer moderate to high flow events that trigger adult Chinook Salmon upstream migration. In order to explore this hypothesis, Sonoma Water compiled daily video counts of Chinook Salmon along with daily summaries of multiple environmental conditions to determine if CVD flood control releases were an important factor in triggering upstream migration of Chinook Salmon.[436] Note, this analysis focuses on migration cues; a full analysis of salmonid upstream migration, including flow and non-flow factors, is provided below under Section 6.2.3.

Daily fish counts from the underwater video cameras were compiled along with daily average flow from CVD releases, daily average flow from USGS stream gages at Hopland, Healdsburg, and Hacienda; rainfall at the Venado rainfall gage; and stage at the USGS stream gage at the Highway One Bridge near Jenner. Stage data from the Jenner Visitor's Center gage was also used to identify the occurrence of river mouth closures, which temporarily block Chinook Salmon in the ocean from entering the Russian River. During river mouth closures, stage in the Russian

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[434] Jasperse et al., 2020. *Op. cit.*

[435] Jasperse et al., 2020. *Op. cit.*

[436] Jasperse et al., 2020, Appendix H

River Estuary increases until the river mouth breaches, when stage then rapidly decreases. These data were displayed graphically and migration patterns were visually compared to environmental patterns.[437] In total, 17 years of Chinook migration data and 19 years of environmental data were investigated.[438]

Species Effects

The analysis demonstrated that while CVD fall flood control releases appear to influence the migration in a small number of years, releases are not the typical environmental cue that triggers upstream migrations. The typical environmental cues that trigger upstream migration appear to be seasonality (change in temperature or photoperiod), breaching of the barrier beach that periodically forms at the mouth of the river, river stage, and rain events. Seasonality is likely one of the most significant environmental cues for upstream migration. The specific seasonal mechanisms that trigger migration may be shortening of photoperiod or a decrease in stream temperature. The run timing of all anadromous salmonids in the Russian River has likely adapted to the local Mediterranean climate where hot dry summers create inhospitable conditions and wet cool winters provide suitable stream temperatures and ample flow. Year to year variability in the beginning and end of the runs may be in part due to river mouth closures and the timing of the first rains. The natural formation of a barrier beach at the river mouth that temporarily blocks adults from entering the Russian River appears to have a strong influence on daily fish counts. One example of the effect of river mouth closures on daily fish counts occurred in 2006 when a barrier beach formed in mid-October and breached in late-October. During this event, Chinook Salmon were detected at Sonoma Water’s seasonal dam prior to closure of the mouth, declined during the closure, and counts increased significantly after a breach. If the Deviation with application of FIRO procedures results in pre-releases during a fall closure, they may increase stage in the Estuary at a faster rate than would occur with more typical fall river flows. However, at this time of year, large wave events or early rain events that can occur concurrently with FIRO-informed releases may also impact the rate of rise in water surface elevations in the Estuary. It would be difficult to attribute an increase in the stage rate of rise only to FIRO-informed releases. Also, timing of early releases ahead of a FIRO-informed release, the timing of this release reaching the Estuary, and arrival of the release may align at a time that inflows are already increasing from the release event. The combination of these conditions could also cause the Estuary to reach flood stage sooner and may require a management action such as breaching the barrier beach in order to reduce flood risk.

Based on fish counts at the Mirabel dam, it appears that rain events are a strong environmental cue for migration. The specific environmental cues related to rain events may be changes in water temperature, water chemistry, turbidity, and low barometric pressure. Regardless of the specific mechanism, rain events (even small rain events which do not contribute significantly to flow) appear to have a strong effect on migration.

Flow and water depth over shallow riffles in the lower Russian River is a factor that can affect Chinook Salmon run timing. Using flow as a proxy for stage, there is some evidence flows below

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[437] Jasperse et al., 2020, Appendix H.

[438] Jasperse et al., 2020, Appendix H.

135 cfs may limit Chinook Salmon from moving through the lower Russian River.[439] However, flow in the lower Russian River is rarely below 135 cfs during the Chinook Salmon migration season. As noted above, this analysis focuses on migration cues; a full analysis of salmonid upstream migration, including flow and non-flow factors, is provided below under Section 6.2.3.

In sum, the Proposed Action (continuation of the Deviation from WY 2021 to 2026 with application of FIRO procedures) would be a continuation of operations from current (2021 to present under baseline) into the future (Proposed Action). As a result, proposed flood control operations under the Proposed Action are unlikely to negatively affect the timing of upstream movement of Chinook Salmon and, albeit to a lesser extent, steelhead (due to run timing occurring later in the year) and Coho Salmon (due to later run timing and limited distribution in the upper Russian River), or the river conditions required for safe passage. Flood releases during the fall are uncommon and are not the typical environmental cue that triggers anadromous salmonids to migrate upstream in the Russian River. It is likely that seasonality, the absence of a barrier beach at the river mouth, and rain events are more typical environmental cues that encourage adult anadromous salmonids to migrate upstream. Thus, current and proposed operations (Deviation) with application of FIRO procedures are likely to have a negligible effect on the upstream migratory cues of these species.

6.1.1.3 Turbidity[440]

Habitat Effects

Flood control releases (i.e., generally between November 1 and March 31) from CVD into the East Fork Russian River have the potential to contribute to increased turbidity in the Russian River. Photographic documentation indicates that although background turbidity in the West Fork also increases during and after storm events, the turbidity released from CVD can be noticeably higher and increases the levels in the mainstem Russian River downstream. The primary adverse impact from turbidity associated with flood control releases is the potential for smothering salmonid eggs and larvae in redds should suspended sediment settle out as flows decline. Redds closer to CVD would be expected to incur the greatest impacts because the turbidity dissipates moving downstream. Jimtown in the Alexander Valley is thought to be the lower limit of observable turbidity influenced by CVD flow releases.[441]

Species Effects

Chinook Salmon in particular spawn in the upper Russian River near CVD and so this species would be most likely to be affected. USACE (unpublished data) assessed turbidity impact thresholds for deposition of fines into salmonid redds using turbidity data collected from the Russian River watershed and a model from Newcombe and Jensen (1996; their Figure 4). Turbidity measurements of 0.6 to 28 nephelometric turbidity units (NTU) were considered sub-lethal and those greater than 28 NTU were considered lethal, although there is considerable

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[439] Sonoma County Water Agency. 2016. Fish Habitat Flows and Water Rights Project Draft Environmental Impact Report. July 2016.

[440] Turbidity can result from both CVD flood control operations and CVD water supply releases. Analysis of turbidity is described within the CVD Flood Control Operations section for editorial purposes.

[441] Jeff Church, Sonoma Water, pers. comm., April 29, 2021

uncertainty associated with these thresholds. Specifically, the threshold between sub-lethal and lethal effects is not well defined and the minimum value was selected for analysis which may greatly overestimate the likelihood of lethal effects. Additionally, consecutive days of exposure may be required to achieve adverse impacts and was not accounted for in the analysis. The threshold exceedance values presented below should be considered only as a relative comparison of potential impacts among sites.

Sub-lethal and lethal levels of turbidity were present on 34 percent and 43 percent of days, respectively, just downstream of CVD during the fall and winter. Turbidity levels measured at Hopland approximately 19 km downstream showed a somewhat different pattern (i.e., sub-lethal on 75 percent of days and lethal on 25 percent of days). Thus, lethal levels of turbidity occurred more often at CVD, but a minimum of the sub-lethal threshold being exceeded occurred on 100 percent of the days at Hopland and only 77 percent of the days at CVD. Turbidity conditions on the West Fork upstream of the East Fork confluence and the effects of CVD inflows were relatively better than those measured at CVD or Hopland. West Fork turbidity levels were in the sub-lethal range on 64 percent of days and lethal range on 13 percent of days in the fall and winter.

Less is known about turbidity released from WSD into Dry Creek. However, Coho Salmon, Chinook Salmon, and steelhead all are known to spawn in Dry Creek and so potentially could be adversely affected by sediment settling in redds. Turbidity levels measured at Lambert Bridge on Dry Creek were in the sub-lethal range on 100 percent of days in the fall and winter.

6.1.1.4 Streambed Scour

Habitat Effects

In the *2008 Biological Opinion*¸ the potential for flow releases from CVD during flood control operations to scour the streambed and salmonid redd sites in the mainstem Russian River downstream of CVD (the Ukiah Reach) was identified as a potential effect mechanism warranting further analysis. Studies in support of the analysis of the streambed scour determined that flows in excess of 4,200 cfs initiate sediment transport and the potential for redd scour.[442] Such flows are termed channel-forming flows.

The risk for increased scour during the wettest years can be driven by flow release sequencing during flood control operations at CVD. For instance, during large storms, when discharge in the Russian River exceeds channel forming flows, USACE generally releases low flows from CVD to minimize flooding in Ukiah and Hopland. Once Russian River discharge begins to fall, CVD flow releases are increased to evacuate water that has been stored during winter storms. These post storm flood releases range between 1,000 to 6,400 cfs depending on reservoir stage, and can by themselves, or in combination with contributing main stem flows, equal or exceed channel forming flows. Longer channel forming flow duration could subject redds to more scour than would otherwise occur, particularly during winters with more rainfall. Moreover, flood control

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442 Florsheim J.L., Goodwin, P. (Philip Williams and Associates Ltd., San Francisco, CA). 1995. Geomorphic and hydrologic conditions in the Russian River, California: Historic trends and existing conditions. Revised 1995. [place unknown]: California State Coastal Conservancy, Mendocino County Water Agency, Circuit Rider Productions, Inc.

releases during the wettest years may lead to larger flows that would occur while at the same time increasing their duration.

The *2008 Biological Opinion* streambed scour criteria were applied to evaluate the potential for flow releases from CVD during flood control operations to increase the duration of channel-forming flows over those that would occur at the Ukiah Gage alone. This evaluation was done for simulated proposed flood control operations (e.g., the Major Deviation with application of FIRO procedures) and for simulated baseline conditions. In addition, an analysis of the duration of scouring flows based on an estimate of stream flow without CVD was developed.

The number days in each water year exceeding 4,200 for each flow record were tallied to yield the duration, in days, of flows meeting the criteria. Hence, flow duration was calculated for the Ukiah Gage alone, CVD flow releases summed with the Ukiah Gage for simulated baseline operations, and CVD flow releases summed with the Ukiah Gage under simulated proposed operations (Proposed Action). In addition, the duration of the sum of flows for the Ukiah Gage and the Calpella Gage > 4,200 was calculated. The difference in duration between simulated proposed and simulated baseline operations was calculated to evaluate the effect of flood control operations on the duration of channel forming flows for each case. To determine the total number of days in a 15-year period that exceeded 4,200 cfs, the average of the 15-year rolling sum of flow duration by water year for each scenario was calculated. In addition, the difference in total duration between the Proposed Action and the baseline for a 15-year period was similarly calculated.

The duration of channel forming flows observed at the Ukiah Gage alone ranged from 1 – 6 days. For simulated Proposed Action conditions (conditions representing Deviations with FIRO procedures), the duration of channel forming flows was 1 – 10 days compared to 1 – 16 days under simulated baseline operations (**Table 6-2**). Therefore, under both the baseline and Proposed Action, channel forming flows in the Ukiah Reach would have receded earlier had flow releases for flood control not been made. However, under the Proposed Action, the duration of channel forming flows was 1 – 6 days shorter than for the baseline. The 15-year total duration of channel forming flows was 25 days under the Proposed Action, while it was 38.2 days for the baseline, a decrease of 13.2 days (see **Table 6-3**). Hence, the adverse effect of redd scour due to increased channel forming flow duration was reduced by 13 days under the Proposed Action, representing a reduction in this potential adverse effect compared to operations without FIRO procedures.

Table 6-2
Comparison of the Number of Days in Each Water Year that Equal or Exceed 4,200 cfs December through March Based on Observed Flow at the Ukiah Gage Summed with Observed CVD Flow, and Observed Flow at the Ukiah Gage Summed with Simulated FIRO Flood Control Operations for Water Years 1986 to 2017.

Water Year	Observed Duration at Ukiah[a] > 4,200 (days)	Duration of Observed Ukiah & Calpella Flow[b] > 4,200 cfs (days)	Duration of Observed Ukiah & Simulated Baseline CVD Flow[3] Flow > 4,200 cfs (days)	Duration of Observed Ukiah & Simulated FIRO CVD Flow[c] Flow > 4,200 cfs (days)	Difference in Duration Between Simulated FIRO and Simulated Baseline (days)
1986	2	No Data	8	5	-3
1987	None	No Data	None	None	None
1988	None	2	None	None	None
1989	None	1	None	None	None
1990	None	None	None	None	None
1991	None	None	None	None	None
1992	None	None	None	None	None
1993	2	5	3	2	-1
1994	None	None	None	None	None
1995	6	15	6	4	-2
1996	None	4	1	3	2
1997	3	8	7	4	-3
1998	1	15	16	10	-6
1999	None	3	3	None	-3
2000	None	2	1	None	-1
2001	None	1	None	None	None
2002	None	2	1	0	-1
2003	None	9	1	0	-1
2004	1	8	4	3	-1
2005	None	1	None	None	None
2006	3	9	8	8	None
2007	None	1	None	None	None
2008	1	4	2	1	-1
2009	None	None	None	None	None
2010	1	4	None	None	None
2011	None	7	1	2	1
2012	None	None	None	None	None
2013	1	3	2	1	-1
2014	None	None	None	None	None
2015	1	1	None	None	-None
2016	None	4	1	2	1
2017	1	10	9	4	-5

NOTES:

a Daily data from USGS Gage 11461000
b Daily data from USGS Gage 11461500 (period of record starts in water year 1988)
c Daily data based on simulations of baseline and proposed flood control operations

TABLE 6-3
FIFTEEN-YEAR AVERAGE FREQUENCY NUMBER OF DAYS IN EACH WATER YEAR THAT EQUAL OR EXCEED 4,200 CFS DECEMBER THROUGH MARCH BASED ON OBSERVED FLOW AT THE UKIAH GAGE SUMMED WITH OBSERVED CVD FLOW, AND OBSERVED FLOW AT THE UKIAH GAGE SUMMED WITH SIMULATED FIRO FLOOD CONTROL OPERATIONS FOR WATER YEARS 1986 TO 2017.

15-year Total Duration of Ukiah Flow[a] > 4,200 cfs (days)	15-year Total Duration Observed Ukiah & Calpella Combined Flow[b] > 4,200 cfs (days)	15-year Total Duration Observed Ukiah & Simulated Baseline CVD Flow[c] Combined > 4,200 cfs (days)	15-year Total Duration of Observed Ukiah & Simulated FIRO CVD Flow 3[2] > 4,200 cfs (days)	15-year Total Difference in Duration Between Simulated FIRO and Simulated Baseline (days)
11.3	67.3	38.2	25.0	-13.2

NOTES:
a Daily data from USGS Gage 11461000
b Daily data from USGS Gage 11461500 (period of record starts in water year 1988)
c Daily data based on simulations of baseline and proposed flood control operations

Species Effects

Due to the lack of site-specific data for this area of the Russian River, a review of May et al. (2009)[443] was conducted to inform the understanding of the relationship among river discharge, bed mobility, and scour depths in areas used by spawning salmonids. May et al. (2009) evaluated high flow releases from Lewiston Dam on the Trinity River to determine the level of bed mobility that may scour Chinook Salmon redds and impact redd viability. The *2008 Biological Opinion* relied on May et al. (2007)[444] (earlier reporting on the same study) to inform the effects analysis. More contemporary reviews concluded that May et al. (2007 and 2009) remains the best available science associated with this specific topic area (see Harrison et al. 2019; Munsch et al. 2020).[445] [446]

Although CVD increases the duration of flows that have the ability to mobilize the streambed, Chinook Salmon and steelhead redds are typically constructed in stable parts of the channel, such as channel margins, where both bed mobility and redd scour potential remain low and have a lower risk of being scoured to the depth of the egg pocket.[447] These findings are also further substantiated by a more recent study conducted on the Yakima River (Roni et al. 2015).[448]

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[443] May, C. L., Pryor, B., Lisle, T. E., & Lang, M. 2009. Coupling hydrodynamic modeling and empirical measures of bed mobility to predict the risk of scour and fill of salmon redds in a large regulated river. Water Resources Research, 45, W05402. https://doi.org/10.1029/2007WR006498

[444] May, C.L., Pryor, B., Lisle, T.E., and M.M. Lang. 2007. Assessing the risk of redd scour on the Trinity River. Prepared for the Bureau of Reclamation, Trinity River Restoration Program, Weaverville, CA. 63p.

[445] Harrison, L. R., Bray, E., Overstreet, B., Legleiter, C., Brown, R. A., Merz, J. E., et al. 2019. Physical controls on salmon redd site selection in restored reaches of a regulated, gravel-bed river Water Resources Research, 55. https://doi.org/10.1029/2018WR024428

[446] Munsch, S. H., K. S. Andrews, L. G. Crozier, R. Fonner, J. L. Gosselin, C. M. Greene, C. J. Harvey, J. I. Lundin, G. R. Pess, J. F. Samhouri, and W. H. Satterthwaite. 2020. Potential for ecological nonlinearities and thresholds to inform Pacific salmon management. Ecosphere 11(12):e03302. 10.1002/ecs2.3302

[447] May et al. 2009. *Op cit.*

[448] Roni, P., Johnson, C., DeBoer, T., Pess, G., Dittman, A., and D. Sear. 2015. Interannaul variability in the effects of physical habitat and parentage on Chinook salmon egg-to-fry survival. Canadian Journal of Fisheries and Aquatic Sciences. 73. 10.1139/cjfas-2015-0372.

Roni et al. (2015)[449] also found that redds in river reaches of unregulated portions of a watershed are more likely to experience scour than those in regulated portions because of muting effects associated with reservoir operations. This finding is consistent with the analysis presented above showing a substantially higher number of scour threshold exceedance events associated with flows without CVD present (see Table 6-3: Ukiah & Calpella Combined Flow > 4,200 cfs (days)).

Chinook Salmon redds have the most potential to be scoured by CVD flood releases. Construction of redds by adult Chinook Salmon from October to mid-December makes them susceptible to CVD flood releases from December through February. Flood releases that contribute to flows of greater than 4,200 cfs in the upper eight km (Ukiah Reach) are expected to cause mobilization of the streambed and adversely affect some Chinook redds. Based on the available information, it is estimated that 5 to 10 percent of the Chinook Salmon redd areas in the upper main stem may be scoured by CVD flood releases. The estimate of five to ten percent is based on information for redd scour as reported in May et al. (2007) and updated in May et al. (2009) and channel conditions in the upper Russian River.

To estimate the number of Chinook Salmon redds that may be scoured by CVD flood operations the *2008 Biological Opinion* used site specific Chinook Salmon redd counts reported by Sonoma Water (SCWA 2008),[450] which remains the best available information on spawning and redd distribution in the upper Russian River. Sonoma Water (2008)[451] reported that the Ukiah Reach of the mainstem is an important spawning area for Chinook Salmon, with redd densities ranging from 7.5 redds/km in 2006 to 15.5 redds/km in 2002. Based on these densities, 60 to 125 Chinook Salmon redds could be exposed to total or partial scouring in the upper 8 km of the mainstem Russian River. Based on the NMFS (2008) estimate of 5 to 10 percent of Chinook redds expected to be scoured, it can be estimated that between 3 and 13 redds are likely to be scoured during each year that CVD extends the duration of 1 to 2-year flood events (estimated at approximately 4,200 cfs). Scour of Chinook Salmon redds is expected to decrease survival of embryos and pre-emergent Chinook Salmon fry by physically dislodging embryos and pre-emergent fry from the protection of the redd during high flows. Chinook Salmon redd scour is expected to occur when flood events exceeding 4,200 cfs occur in the upper mainstem, or approximately 25 days within the 15-year average frequency evaluation period that CVD conducts flood control operations (see Table 6-3). While these scour events represent an adverse effect to Chinook Salmon redds, the proposed operations reduce this effect when compared to the condition prior to FIRO procedures being implemented, where approximately 38 days of flood events exceeding 4,200 cfs were estimated to occur within the same 15-year average frequency evaluation period that CVD conducts flood control operations (see Table 6-3). Further, it is important to note that streambed scour is a natural phenomenon. As described above, Roni et al. (2015)[452] found that redds in unregulated rivers are more likely to experience scour than those in regulated rivers. This finding is consistent with the analysis presented above showing a substantially higher number of scour

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[449] Roni et al. 2009. *Op cit.*

[450] Sonoma County Water Agency. 2008. Chinook Salmon Spawning Study Russian River Fall 2002-2007.

[451] Sonoma County Water Agency. 2008. *Op sit.*

[452] Roni et al. 2009. *Op cit.*

threshold exceedance events (67 events estimated) associated with estimated flows without CVD present (see Table 6-3).

Few steelhead redds are expected to be impacted by CVD flood control releases due to the timing of steelhead redd construction. Most steelhead spawning in the Ukiah reach of the main stem occurs in March and April. Therefore, some redds that may be constructed in February and March could be affected by CVD flood releases, but the majority of steelhead redds constructed in the Russian River main stem are not likely to be affected by scour or bed mobilization from CVD flood operations occurring from December through March.

6.1.1.5 Bank Erosion

Habitat Effects

Bank erosion and deposition are normative geomorphic processes and integral in the formation and maintenance of riparian and aquatic habitat for an array of organisms, including salmonid fishes.[453,454,455] There is a well-established linkage between episodic disturbance due to lateral channel migration and riparian and aquatic habitat diversity.[456,457,458] Such habitat diversity, adds overall resilience to riverine ecosystems by creating multiple floodplain and channel habitat seral stages that harbor a diversity of communities.

In general, sediment eroded from a particular bank will be deposited downstream. This sequential, downstream pattern of erosion and deposition yields cycle of habitat turnover and formation (e.g., pools and riffles). During large, less frequent floods, substantial erosion and overbank deposition may occur, and associated habitat disturbance may also be substantial. During moderate floods, bank erosion and deposition will be more or less contained within the banks of the active channel, and the magnitude of habitat disturbance will be more moderate. Under unregulated hydrologic conditions, seasonal episodes of bank erosion and deposition generally yield no net loss of aquatic habitat. However, under regulated hydrology, the duration of moderate to large flows can extend beyond what is typical under unregulated conditions and may yield an imbalance in bank erosion and sediment transport relative to deposition, .and

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[453] Benda, L., T. J. Beechie, R. C. Wissmar, & A. Johnson, 1992. Morphology and Evolution of Salmonid Habitats in a Recently Deglaciated River Basin, Washington State, USA. Canadian Journal of Fisheries and Aquatic Sciences 49: 1246–1256.

[454] Beechie, T. J., M. Liermann, M. M. Pollock, S. Baker, & J. Davies, 2006. Channel pattern and river-floodplain dynamics in forested mountain river systems. Geomorphology 78: 124–141.

[455] Joan L. Florsheim, Jeffrey F. Mount, and Anne Chin 2008. Bank Erosion as a Desirable Attribute of Rivers, BioScience 58(6), 519-529.

[456] Poole, G. C., 2002. Fluvial landscape ecology: addressing uniqueness within the river discontinuum. Freshwater Biology 47: 641–660.

[457] Naiman, R. J., J. S. Bechtold, T. J. Beechie, J. J. Latterell, & R. Van Pelt, 2010. A Process-Based View of Floodplain Forest Patterns in Coastal River Valleys of the Pacific Northwest. Ecosystems 13.

[458] Townsend, C. R., M. R. Scarsbrook, & S. Doledec, 1997. The intermediate disturbance hypothesis, and biodiversity in streams. Limnology and Oceanography 42: 938–949.

associated benefits of disturbance that would other.[459,460,461,462,463] A potential effect of sustained moderate and high flows is excess sediment erosion and transport leading to habitat degradation and loss over time. Direct effects may include bank sloughing and increased bed load that could have a detrimental effect on aquatic biota during a particular flood. Of particular concern is the threat to incubating salmon eggs in the gravel due to excess sediment deposition.

Bank erosion impacts due to flood operations of CVD were assessed in the *2008 Biological Opinion*. The *2008 Biological Opinion* analysis utilized hydrologic data provided by the USACE and was conducted based on an evaluation of the magnitude and frequency of stream flows above a threshold discharge identified as the flow at which bank erosion is initiated. Initiation of bank erosion was found to occur at flows of 6,000 cfs at Hopland and 8,000 cfs at Cloverdale.

The risk for increased bank erosion during the wettest years can be driven by flow release sequencing during flood control operations. For instance, during large storms, when discharge in the Russian River exceeds bank-eroding flows, USACE generally releases low flows from CVD to minimize flooding in Ukiah and Hopland. Once Russian River discharge begins to fall, CVD flow releases are increased to evacuate water that has been stored during winter storms. These post storm flood releases range between 1,000 to 6,400 cfs depending on reservoir stage and can by themselves or in combination with mainstem flows equal or exceed bank-eroding flows. Longer bank-eroding flow duration would likely increase the potential for bank erosion. Moreover, flood control releases during the wettest years may lead to larger flows that would occur while at the same time increasing their duration.

The bank erosion criteria were applied to evaluate the potential for flow releases from CVD during flood control operations to increase the duration of bank eroding flows over those that would occur at the Hopland Gage alone. This evaluation was done for simulated proposed flood control operations and for simulated conditions without the Deviation with FIRO procedures.

Flow measured at the Hopland Gage includes flows released from CVD. To calculate flow at Hopland alone for observed conditions, flow measured at CVD is subtracted from flow at Hopland, while also accounting for flow accretion and routing in the reach below CVD. To calculate flow at Hopland under the Proposed Action, the calculated value for flow at Hopland alone was summed with flows from CVD under simulated proposed operations. For conditions without the Deviation and FIRO procedures, the same sum was calculated based on simulated baseline operations.

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[459] Poff, N. L., & J. K. H. Zimmerman, 2010. Ecological responses to altered flow regimes: a literature review to inform the science and management of environmental flows. Freshwater Biology 55: 194–205.

[460] Grant, G. E., 2012. The Geomorphic Response of Gravel-bed Rivers to Dams: Perspectives and Prospects *In* Church, M., P. M. Biron, & A. G. Roy (eds), Gravel-bed Rivers: Processes, Tools, Environments, First Edition. Edited by Michael Church. John Wiley & Sons, Ltd. 165–181.

[461] Yarnell SM, Petts GE, Schmidt JC, Whipple AA, Beller EE, Dahm CN, Goodwin P, Viers JH. 2015. Functional Flows in Modified Riverscapes: Hydrographs, Habitats and Opportunities. BioScience. 65:10:963–972.

[462] YH. Piégay, N. Lamouroux, 2017. Enlarging spatial and temporal scales for riverine biophysical diagnosis and adaptive management, Journal of Environmental Management, Volume 202, Part 2, 2017, Pages 333-336.

[463] Vietz, G.J., Lintern, A., Webb, J.A. et al. River Bank Erosion and the Influence of Environmental Flow Management. Environmental Management 61, 454–468 (2018).

For observed flows at the Hopland Gage alone in those years when bank-eroding flows occurred, their duration was 1-12 days long. For those years when flow exceeded bank-eroding flows under the Proposed Action their duration was 1-21 days compared to 1-23 days under conditions without the Deviation and FIRO procedures (**Table 6-4**). Therefore, under the Proposed Action, bank-eroding flows upstream of Hopland would have receded earlier had flow releases for flood control not been made. However, under the Proposed Action the duration of bank-eroding flows were always of shorter duration than under conditions without the Deviation and FIRO procedures (Table 6-4). The 15-year total duration of bank-eroding flows was 75 days under the Proposed Action, while it was 87 days for operations without the Deviation and FIRO procedures, a decrease of 12 days (see **Table 6-5**). Therefore, the adverse effect to salmonid embryos and fry due to sedimentation of redds in the mainstem Russian River between CVD and Hopland because of increased bank-eroding flow duration was reduced by 12 days under the Proposed Action compared to operations without the Deviation and FIRO procedures.

Species Effects

The *2008 Biological Opinion* identified the potential for sustained moderate to large flow releases from CVD during flood control operations to initiate bank erosion, leading to loss of salmonid embryos and fry due to sedimentation of eggs in the gravel in the mainstem Russian River between CVD and Hopland as a potential adverse effect mechanism. As described above, the 15-year average frequency total duration of bank-eroding flows (flows exceeding 6,000 cfs at Hopland) was 75 days under the Proposed Action, while it was 87 days for conditions without the Deviation and FIRO procedures, a decrease of 12 days (see Table 6-5). Bank erosion contributed by CVD operations may cause some reduction in survival of embryos and emergent fry in spawning areas that are directly affected downstream of bank erosion sites. These failures are expected to occur at few sites given the relatively dense riparian vegetation that exists along most of the upper main stem. Chinook Salmon redds are likely to be affected because bank erosion is more likely to occur from late December through February when Chinook Salmon redds are susceptible to sedimentation. Effects to Chinook Salmon redds are expected to be confined to short reaches below bank erosion sites.

It is important to note that bank erosion is also a natural process in active river systems and juvenile Chinook Salmon and steelhead may benefit from bank failures along the upper mainstem Russian River. These failures typically deliver vegetation in the form of small and large organic debris that improves winter habitat for salmonids and is likely to improve rearing conditions for juvenile steelhead during the summer months.

TABLE 6-4
COMPARISON OF THE NUMBER OF DAYS IN EACH WATER YEAR THAT EQUAL OR EXCEED 6,000 CFS DECEMBER THROUGH MARCH BASED ON OBSERVED FLOW AT THE HOPLAND GAGE SUMMED WITH OBSERVED CVD FLOW AND OBSERVED FLOW AT THE HOPLAND GAGE SUMMED WITH SIMULATED FIRO FLOOD CONTROL OPERATIONS FOR WATER YEARS 1986 TO 2017.

Water Year	Observed Duration at Hopland Flow[a] Minus CVD Flow[b] > 6,000 cfs (days)	Duration of Simulated Baseline Hopland[b] > 6,000 cfs (days)	Duration of Simulated FIRO Hopland[c] Flow > 6,000 cfs (days)	Difference in Duration Between Simulated FIRO and Simulated Baseline (days)
1986	7	10	9	-1
1987	None	None	None	None
1988	None	1	1	None
1989	None	1	None	-1
1990	None	None	None	None
1991	None	None	None	None
1992	None	None	None	None
1993	5	5	5	None
1994	None	None	None	None
1995	11	23	17	-6
1996	3	9	8	-1
1997	6	9	9	None
1998	10	23	21	-2
1999	3	5	4	-1
2000	1	3	1	-2
2001	1	None	None	None
2002	1	2	1	-1
2003	6	8	7	-1
2004	7	9	8	-1
2005	1	1	1	None
2006	9	14	14	None
2007	None	None	None	None
2008	4	4	4	None
2009	None	None	None	None
2010	3	4	4	None
2011	4	7	7	None
2012	None	None	None	None
2013	3	6	4	-2
2014	None	None	None	None
2015	1	2	1	-1
2016	2	8	5	-3
2017	12	22	17	-5

NOTES:

a Daily data from USGS Gage at Hopland 11462500
b Daily data from USACE CVD Gage
c Daily data based on Simulations of the Hybrid Alternative under proposed FIRO flood control operations

TABLE 6-5
FIFTEEN-YEAR AVERAGE FREQUENCY THE NUMBER OF DAYS IN EACH WATER YEAR THAT EQUAL OR EXCEED 6,000 CFS DECEMBER THROUGH MARCH BASED ON OBSERVED FLOW AT THE HOPLAND GAGE SUMMED WITH OBSERVED CVD FLOW AND OBSERVED FLOW AT THE HOPLAND GAGE SUMMED WITH SIMULATED FIRO FLOOD CONTROL OPERATIONS FOR WATER YEARS 1986 TO 2017.

15-year Sum of No. of Days Hopland[a] Combined Flow > 6,000 cfs (days)	15-year Sum of No. of Days Hopland & CVD Flow[b] Combined Flow > 6,000 cfs (days)	15-year Sum of No. of Days Under the FIRO Simulated Hybrid Alternative[c] > 6,000 cfs (days)	15-year Total Difference in Duration Between Simulated and Observed (days)
50	87	75	-12

NOTES:
a Daily data from USGS Gage at Hopland 11462500 minus observed daily data from CVD
b Daily data from USGS Gage at Hopland 11462500
c Daily data from USGS Gage at Hopland 11462500 minus observed daily data from CVD plus simulated CVD daily data

6.1.1.6 Ramping Rates (Voluntary Conservation Measure)

Habitat Effects

As discussed in the Ramping Rates voluntary conservation measure for CVD under the Proposed Action (Section 3.10), stranding mortality of juvenile salmonids in the Ukiah Reach is a concern (see also *2008 Biological Opinion*). Studies conducted by NMFS and USACE in December of 2012 (NMFS and USACE 2013) found that the potential for stranding in the Ukiah Reach was highest when flow released from CVD were between 1,000 and 2,500 cfs. Given the high potential for stranding in the Ukiah reach when flows are < 2,500 cfs, protective ramping criteria specify that down ramping rates should be no greater than 100 cfs/hr between November 1st and March 15th.

Flow releases for flood control may occasionally require down ramping rates in excess of 100 cfs/hr in circumstances where more expedient operations are required to meet operational criteria for flood control. To understand the frequency of down ramping rates of flow from CVD, a comparison to the frequency of naturally-occurring down ramping rates at the Ukiah Gage was made. The period of record for this analysis was water years 2011 – 2021, those years when hourly discharge records for CVD were available.[464]

The frequency of naturally-occurring down ramping rates > 100 cfs/hr for flows ≤ 2,500 cfs was higher in all months for the period of record, ranging from as few as four events in the first half of November to as many as 61 in the second half of December (**Figure 6-9**). In contrast, ramping rates >100 cfs/hr from CVD flood releases were as low as zero in the second half of November to as many as 29 in the second half of March (Figure 6-9). Given these findings, so long as flood control operations maintain the frequency of down ramping events of ≥ 100 cfs/hr for flows ≤ 2,500 cfs at or below the frequency of current conditions as shown in Figure 6-9, then adverse effects on salmonid juveniles rearing in the Ukiah Reach should be similar to, or less than those that occur under natural conditions with implementation of this conservation measure.

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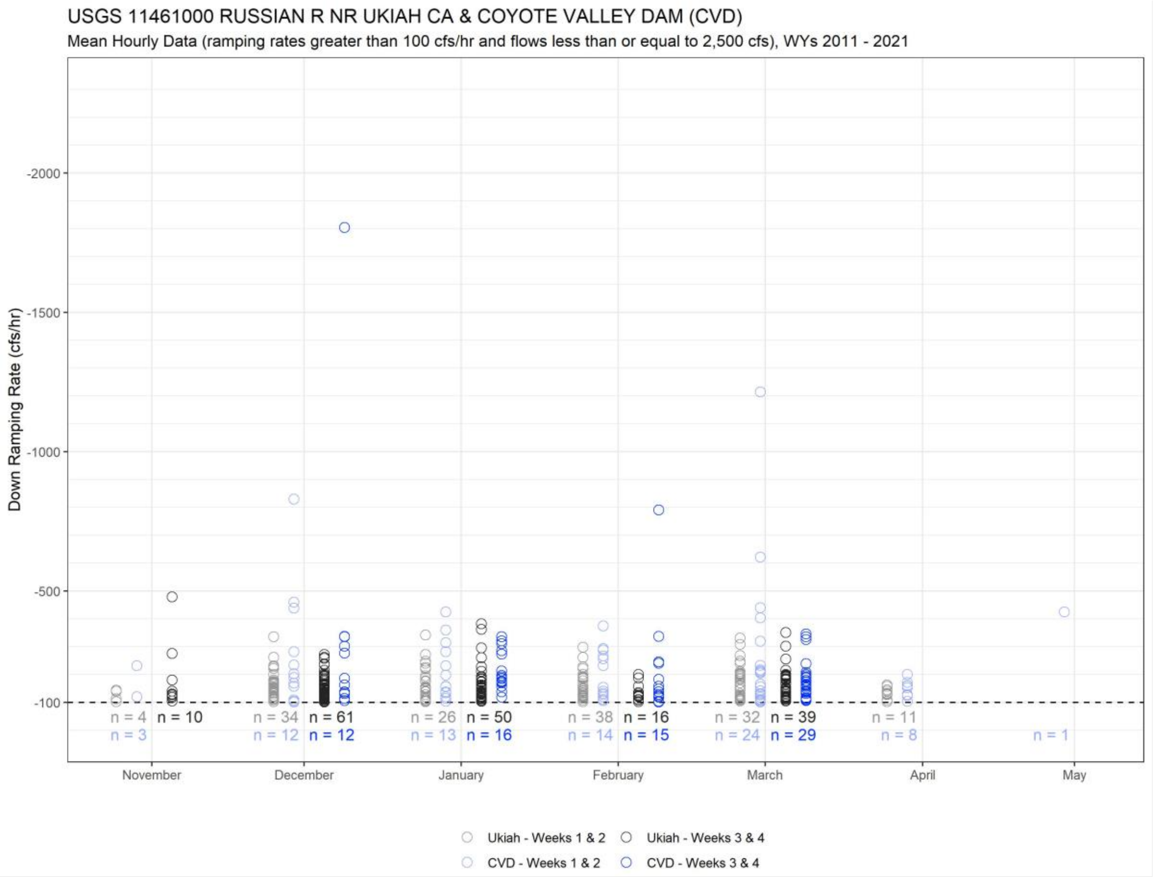
[464] Discharge records at CVD prior to water year 2011 consist only of daily discharge



SOURCE: USGS Stream Gaging Station 11461000

Figure 6-9
Comparison of naturally-occurring and Coyote Valley Dam release down ramping rates > 100 cfs/hr for flows ≤ 2,500 cfs at the Russian River Near Ukiah stream gage (USGS Gaging Station 11461000 for water years 2011 through 2021).

Species Effects

Both Chinook Salmon and steelhead fry and juveniles have the potential to be stranded in isolated pools or beached in dewatered areas created during flood control flow ramp downs. Fry, which are more vulnerable than older juveniles, are poor swimmers and are known to inhabit shallow margins of rivers[465] where flow reductions are likely to have greater effects on aquatic habitat (these areas will drain down first). Ramping rates that result in river stage changes of one inch or less per hour are recommended by Hunter (1992) to protect steelhead fry, and two inches per hour or less to protect juveniles. Based on a review of gage data (Ukiah USGS Gaging Station 11461000), ramp down rates of 100 cfs/hr at CVD are expected to produce river stage changes of approximately 3.3 inches/hr for discharges ranging between 1,000 cfs to 2,500 cfs. These stage changes have the potential to strand fry and juveniles, although, as described above, some

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[465] Hunter, M.A. 1992. Hydropower flow fluctuations and salmonids: a review of the biological effects, mechanical causes, and options for migration. State of Washington, Department of Fisheries, Technical Report No. 119, Olympia, Washington.

dampening of stranding effects may occur due to late winter and spring storms. Any potential stranded fry and juveniles are likely to experience higher rates of predation. Some fry and juveniles may be stranded in disconnected pool areas that may not become reconnected depending on flow regime, ensuring the loss of these fish. A lesser number of fish are likely to become beached and perish due to asphyxiation.

The stranding or beaching that occurs in the upper mainstem Russian River below the East Branch is not expected to affect Chinook Salmon and steelhead fry and juveniles inhabiting this 64-mile km stream reach. As noted in the *2008 Biological Opinion*, NMFS staff biologists have surveyed this area during the winter months (and during fall pre-flood inspections) and concluded that based on the number of low gradient bars and other cover that exist for Chinook Salmon and steelhead fry and juveniles, only a small portion of the fry and juvenile population in this upper four six miles km may become stranded in isolated pools or beached by CVD flood control flow ramping actions.

The creation of intermittent and dewatered areas of the channel downstream of CVD during pre-flood/periodic inspections is expected to potentially strand, but not injure or kill, juvenile steelhead along the East Fork Russian River and mainstem Russian River when flow is ramped down. Surveys conducted by NMFS and USACE personnel during these inspections from 1998 to 2004 have documented juvenile steelhead stranded in disconnected pools. Past monitoring by NMFS staff has found that pools with stranded juvenile fish are reconnected with the wetted channel when flow is quickly restored during the ramp up phase of the action. No mortalities of stranded juvenile steelhead have been detected during any of the stream monitoring surveys conducted during fall pre-flood inspections or during visual surveys since publication of the *2008 Biological Opinion*. These fall inspections should not affect juvenile Chinook Salmon because they will have migrated downstream out of the impacted area prior to the fall. Coho Salmon juveniles are not likely to be present in this area of the river.

The number of juvenile steelhead stranded is likely to vary based on channel conditions. Observations indicate that the buildup of gravel bars has confined the wetted stream, thereby reducing the potential for fishes to become stranded in disconnected pools.

6.1.2 Warm Springs Dam

Baseline conditions for flood control operations at WSD at Lake Mendocino consist of flow releases during those periods when the reservoir elevation is within the flood control pool in accordance guidelines stipulated in the WCM for WSD.

Under the Proposed Action, USACE will continue to manage water releases at Lake Sonoma when the water levels rise above the top of the water supply pool (451.1 feet above MSL) and into the flood control pool. USACE will also manage releases during annual inspections and during maintenance and repairs. Flood control operations at WSD shall proceed according to procedures set out in the Warm Springs Dam WCM.[466] However, USACE and the Russian River

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[466] USACE, 1984. Warm Springs Dam and Lake Sonoma, Dry Creek, California: Water Control Manual. Appendix II to the Master Water Control Manual, Russian River Basin. September 1984.

FIRO Steering Committee[467] are also currently evaluating a Minor Deviation with application of FIRO operating alternatives at Lake Sonoma. Potential Proposed Action with respect to flood control operations for Lake Sonoma are still to be determined, however, any revisions will comply with minimum instream flow requirements in place at the time forecast informed operations are developed. This includes flood control release requirements that stipulate that such releases would be minimized when flows on the Russian River near Guerneville are greater than 35,000 cfs. Under the Proposed Action it is anticipated that weather forecasting tools similar to those used under FIRO at Lake Mendocino will be utilized at Lake Sonoma. The development of FIRO operating procedures at Lake Sonoma will be coordinated with NMFS and CDFW.

6.1.2.1 Streambed Scour

Under the proposed Action WSD flood control operations will likely reduce the frequency of channel-forming flows in Dry Creek, though continued flood control operations under the Proposed Action may contribute to scour of salmonid spawning sites downstream in some years, similar to that under exiting conditions. When scour occurs, a portion of the spawning habitat downstream of WSD may be affected; however, these conditions are dynamic, temporal, and within the range of variability that occurs in natural, as well as, managed systems. Variable hydrology allows spawners to distribute "scour risk" across different areas of the channel, which also minimizes the chance of redd superimposition. See discussion above for CVD.

6.1.2.2 Bank Erosion

Under the Proposed Action, flood control flows are likely to initiate bank erosion in some years. However, based on the analysis of hydrologic data and flows needed to initiate bank scour summarized in the *2008 Biological Opinion*, WSD flood operations are not likely a significant factor contributing to bank erosion in Dry Creek in most years. Given that flood control operations under the Proposed Action are similar to those analyzed under the *2008 Biological Opinion*, potential effects associated with redd scour in Dry Creek downstream of WSD would also be similar are expected to be small.

6.2 Water Supply Operations

Under the Proposed Action, Sonoma Water would propose and implement (upon approval by SWRCB) an interim, seven-year change to its water-right permits in order to modify the hydrologic index to reflect conditions in the Russian River watershed as opposed to the current Decision 1610 index located in the Eel River watershed, and implement changes to Decision 1610 minimum flows consistent with the *2008 Biological Opinion* that calls for adjustments to the minimum flows for Normal and Dry hydrologic conditions, pending completion of permanent changes to Sonoma Water's water rights permits under the Fish Flow Project (see Section 3.2.2, *Water Supply Operations*). Proposed interim and permanent changes to Sonoma Water's water rights permits are intended to address current uncertainties associated with changes in operations

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[467] FIRO Steering Committee includes members from USACE, Sonoa Water, Center for Western Weather and Water Extremes at Scripps Institution of Oceanography, NMFS, NOAA's Earth System Research Laboratory, U.S. Burau of Reclamation, California Nevada River Forecast Center, CW3E, U.S. Geologic Survey, California State Climate Office, Department of Water Resources.

of PG&E's PVP and its impact on water supply reliability in Lake Mendocino and the Russian River watershed. Potential effects from reductions in minimum instream flows relative to those dictated under Decision 1610 are discussed below for both those conditions that are expected to result during interim TUCOs.

Flow throughout the Russian River, Estuary, and Dry Creek during the rainy season from November to April is largely influenced by rainfall and tributary inflows. Instream flows provided through water supply operations are most relevant during the dry season (May to October) when releases from Lake Mendocino and Lake Sonoma contribute a large portion of the flows to the Russian River and Dry Creek. Changes in instream flow in the Russian River and Dry Creek, as well as fluctuations in Lake Mendocino and Lake Sonoma, could affect salmonids depending on the timing and degree of change in flow, and are unique to the species life stage habitat suitability requirements.

Russian River Reservoir Simulation Model

For purposes of the water supply operations analysis, simulated flow for baseline conditions and the Proposed Action (interim petitions and Fish Flow Project) were generated using the Russian River Reservoir Simulation Model (Russian River ResSim). The Russian River-ResSim model was developed by Sonoma Water to be used as a planning tool to simulate the effects of various climatic conditions, levels of demand, and operational criteria on the water supply available for use by Sonoma Water and others. The Russian River ResSim model calculates the releases that must be made from Lake Mendocino and Lake Sonoma, taking into account USACE flood control operations criteria, and revised Decision 1610 minimum streamflow requirements consistent with the *2008 Biological Opinion*. Output from the Russian River ResSim model includes flows at discrete locations (or "junctions") within the Russian River watershed.

The model incorporates 107 complete water years of hydrologic data (1910 – 2017), represented as daily unimpaired tributary flows into the Russian River and Dry Creek. Unimpaired flows are the "natural" flows, unaffected by human-made influences, such as water diversions or reservoir operations. These unimpaired flows, which form the basis of the hydrology in the model, were developed by USGS using their Basin Characterization Model (BCM). This hydrologic model uses historical weather, climate, and hydrologic data to generate the unimpaired flows that are passed to the Russian River ResSim model. Diversions from the Eel River into the Russian River were computed separately by Sonoma Water and have been updated to reflect current conditions associated with PVP operations.

Another major component of the Russian River ResSim model is the distributed losses throughout the Russian River system. These losses include not only the Sonoma Water's diversions, but all other depletions from the watershed including evapotranspiration by riparian vegetation, aquifer recharge, agricultural diversions, and non-Sonoma Water municipal and industrial diversions. Much like the unimpaired flow datasets, system losses were aggregated between each junction. System losses not associated with the Sonoma Water's diversions were estimated through an analysis of historical municipal and industrial data, flow gage data, and climate data. Because the model calculates the reservoir releases necessary to meet minimum stream flow requirements, all water uses in the watershed are satisfied by simulated flow releases, not just demands of the Sonoma Water's transmission system.

The 107 complete water years of hydrologic data (1910 – 2017) represents a wide range of hydrologic variability, including critical (extreme drought, e.g., 1966-1967), dry, normal, and wet conditions. As a result, it allows for a comprehensive analysis of water supply operations effects on habitats and species in the Russian River Watershed. In addition, Sonoma Water is currently working with the USGS to update the hydrologic dataset to include water year 2018 through 2022, which would include the drought period of 2020 through 2022 for future analyses.

6.2.1 Coyote Valley Dam (Russian River)

6.2.1.1 Habitat Effects

Juvenile Rearing

River flow is dominated by reservoir releases earlier in the summer nearer to the dams. In the upper Russian River from the forks down to Healdsburg, reservoir releases often dominate flow from May through October. Downstream of Hopland significant amounts of unimpaired flow can increase flows above that which is released from the reservoir well into July. This period coincides with the spring and summer rearing life stages for Chinook Salmon and steelhead. Coho Salmon habitat does not occur in the mainstem of the Russian River. As discussed in Section 5.4, *Trends in Abundance*, Coho Salmon rearing habitat is not present in the mainstem of the Russian River and is limited to the selected tributaries located primarily in the lower Russian River, including Dry Creek and a few of its tributaries.

The *2008 Biological Opinion* outlined how elevated flows in Dry Creek, the mainstem Russian River, and the Estuary were likely to negatively affect the ability of salmon and steelhead populations to survive and recover in the Russian River watershed. High water velocities associated from artificially elevated summer flows greatly limit the quantity and quality of juvenile coho salmon and steelhead rearing habitat in Dry Creek and juvenile steelhead rearing in the upper Russian River. Reducing minimum flows mandated by Decision 1610 could substantially augment usable rearing habitats for older (age 1+ and late summer age 0+) juvenile coho salmon and steelhead. Such modifications would likely favorably affect salmonid population growth rates and beneficially affect spatial structure of the populations.

To analyze how simulated instream flows (Russian River ResSim) proposed under the seven-year interim petitions and Fish Flow Project (Proposed Action) may alter the quantity of summer rearing habitat, Sonoma Water developed a two-dimensional hydraulic model (Russian River River2D) to assess project-related impacts to steelhead and Chinook Salmon fry and juvenile rearing habitat in the Russian River upstream of Cloverdale.[468] The model estimated depths and velocities within reaches of the river (study sites) over a range of simulated flows. These predicted depths and velocities were then linked to a Habitat Suitability Index (HSI) for different salmonid species and life stages to quantitatively estimate the quantity and quality of habitat in

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[468] Russian River River2D was developed for Russian River Fish Flow Habitat Study (see SCWA, 2016. Russian River Fish Flow Habitat Study Technical Report. Santa Rosa, Ca. Sonoma County Water Agency) and re-applied to flows simulated (ResSim) for the baseline and seven-year petition (Proposed Action).

each reach. The quantity of habitat is often expressed as Weighted Usable Area (WUA), the amount of habitat in a reach adjusted, or "weighted," by habitat quality. The amount of WUA can be compared at different simulated flows to estimate how a range of flows effect salmonid habitat in a modeled reach.

Steelhead

Fry

The River2D model results show that under the Proposed Action (interim petitions and preliminary proposed Fish Flow Project) steelhead fry habitat would change at all sites with a change in minimum instream flow. At the Ukiah reach, model results indicate that steelhead fry WUA would increase with instream flows from approximately 25 cfs to 310 cfs. At Hopland, model results indicate that the WUA would decrease from 25 cfs to approximately 100 cfs then slightly increase as flow increased to 250 cfs (**Figure 6-10**). As flows increased, model projections for the WUA at the Comminsky Station reach would gradually decrease over the range of flows modeled. At Cloverdale, the model projections for the WUA would sharply decrease as flow increased from 25 to 250 cfs.

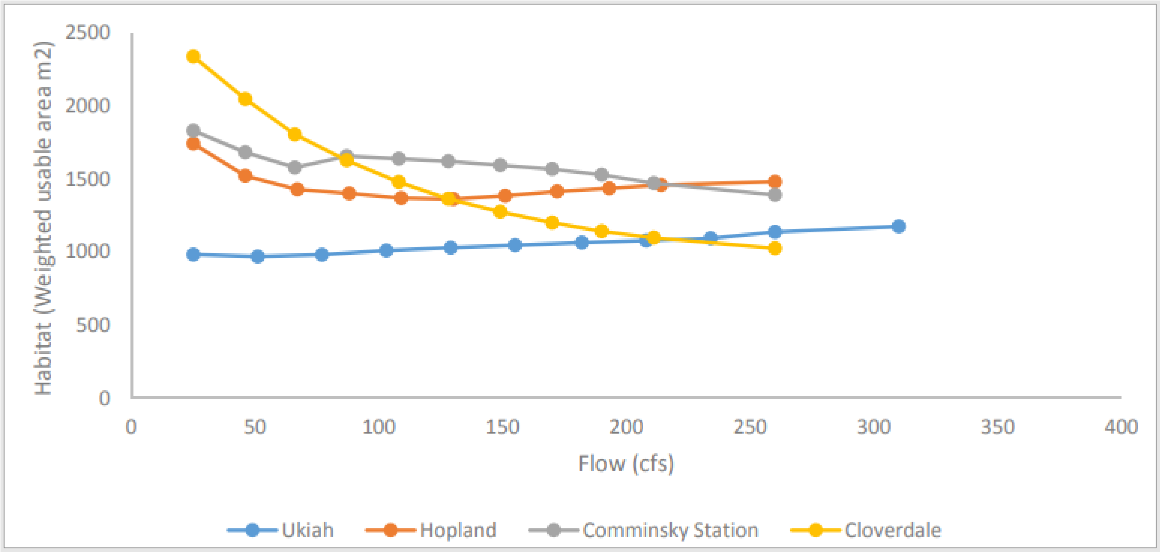

Figure 6-10
Estimated Habitat (WUA) in square meters under the Proposed Action for steelhead fry

When the River2D model results for all reaches are pooled, the mean monthly WUA for steelhead fry ranged from 4,630 m^2 to 5,323 m^2 for simulated flows under the baseline, and from 4,832 m^2 to 5,518 m^2 for simulated flows under the interim petitions and from 4,903 m^2 to 5,453 m^2 for simulated flows under the preliminary proposed Fish Flow Project (Proposed Action) (**Table 6-6**), representing a four percent increase for interim petitions and two (June) and six (May) percent increase for preliminary proposed Fish Flow Project. When considered by reach, the mean monthly WUA for steelhead fry ranged from 1,030 m^2 to 1,608 m^2 depending on the reach and the month for simulated flows under the baseline (**Table 6-7**). Under the Proposed Action, the mean monthly WUA for steelhead fry ranged from 1,018 m^2 to 1,631 m^2 for interim petitions and from 1,005 m^2 to 1,618 m^2 for preliminary proposed Fish Flow Project, depending on the reach and the month (Table 6-7). The largest increase in WUA under the Proposed Action (interim petitions) was in the Cloverdale Reach, which was thirteen percent larger compared to simulated flows under the baseline in June. In contrast, there was five percent less WUA under the Proposed Action (interim petitions) in the Ukiah Reach, which was the largest decrease.

Table 6-6
Estimated Amount of WUA in Upper Russian River (Pooled Reaches) for Steelhead Fry and Juveniles in River2D Using the Monthly Mean Flows from Russian River ResSim under Baseline and Proposed (Interim Petitions and Fish Flow Project) Reservoir Operations

Reach	Life Stage	Scenario	May	Jun	Jul	Aug	Sep	Oct	Nov
Russian River	Fry	Baseline (WUA)	4,630	5,323	-	-	-	-	-
		Proposed Interim Petitions (WUA)	4,832	5,518	-	-	-	-	-
		Proposed Interim Petitions Change (%)	4	4	-	-	-	-	-
		Proposed Fish Flow (WUA)	4,903	5,453	-	-	-	-	-
		Proposed Fish Flow Change (%)	6	2	-	-	-	-	-
	Juveniles	Baseline (WUA)	20,467	23,033	23,586	23,683	23,488	22,815	19,984
		Proposed Interim Petitions (WUA)	19,950	22,218	23,012	23,230	23,327	22,859	20,206
		Proposed Interim Petitions Change (%)	-3	-4	-2	-2	-1	0	1
		Proposed Fish Flow (WUA)	20,758	22,620	23,181	23,387	23,504	22,953	20,846
		Proposed Fish Flow Change (%)	1	-2	-2	-1	0	0	4

NOTE: Dashes indicate that this life stage would not be present in the upper Russian River for these months.

SOURCE: SCWA, 2023 (unpublished data); SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

Table 6-7
Estimated Amount of WUA for Steelhead Fry and Juveniles in River2D Using the Monthly Mean Flows from Russian River ResSim under Baseline and Proposed (Interim Petitions and Fish Flow Project) Reservoir Operations

Reach	Life Stage	Monitoring Station	May	Jun	Jul	Aug	Sep	Oct	Nov
Ukiah	Fry	Baseline (WUA)	1,030	1,037	--	--	--	--	--
		Proposed Interim Petitions (WUA)	1,008	1,018	--	--	--	--	--
		Proposed Interim Petitions Change (%)	-2	-2	--	--	--	--	--
		Proposed Fish Flow (WUA)	1,005	1,021	-	-	-		-
		Proposed Fish Flow Change (%)	-2	-2	--	--	--	--	--

TABLE 6-8 (CONTINUED)
ESTIMATED AMOUNT OF WUA FOR STEELHEAD FRY AND JUVENILES IN RIVER2D USING THE MONTHLY MEAN FLOWS FROM RUSSIAN RIVER RESSIM UNDER BASELINE AND PROPOSED (INTERIM PETITIONS AND FISH FLOW PROJECT) RESERVOIR OPERATIONS

Reach	Life Stage	Monitoring Station	May	Jun	Jul	Aug	Sep	Oct	Nov
Ukiah (cont.)	Juveniles	Baseline (WUA)	3,404	3,432	3,490	3,495	3,481	3,425	3,327
		Proposed Interim Petitions (WUA)	3,239	3,331	3,454	3,476	3,474	3,381	3,309
		Proposed Interim Petitions Change (%)	-5	-3	-1	-1	0	-1	-1
		Proposed Fish Flow (WUA)	3,236	3,357	3,464	3,486	3,484	3,433	3,342
		Proposed Fish Flow Change (%)	-5	-2	-1	0	0	0	0
Hopland	Fry	Baseline (WUA)	1,397	1,380	--	--	--	--	--
		Proposed Interim Petitions (WUA)	1,421	1,403	--	--	--	--	--
		Proposed Interim Petitions Change (%)	2	2	--	--	--	--	--
		Proposed Fish Flow (WUA)	1,397	1,385	-	-	-	-	-
		Proposed Fish Flow Change (%)	0	0	--	--	--	--	--
	Juveniles	Baseline (WUA)	6,071	6,076	6,116	6,128	6,126	6,063	6,003
		Proposed Interim Petitions (WUA)	5,907	5,912	6,009	6,061	6,074	5,966	5,982
		Proposed Interim Petitions Change (%)	-3	-3	-2	-1	-1	-2	--
		Proposed Fish Flow (WUA)	5,969	5,983	6,049	6,094	6,110	6,051	6,068
		Proposed Fish Flow Change (%)	-2	-2	-1	-1	0	0	1
Cominsky	Fry	Baseline (WUA)	1,550	1,608	--	--	--	--	--
		Proposed Interim Petitions (WUA)	1,584	1,631	--	--	--	--	--
		Proposed Interim Petitions Change (%)	2	1	--	--	--	--	--
		Proposed Fish Flow (WUA)	1,577	1,618	-	-	-	-	-
		Proposed Fish Flow Change (%)	2	1	--	--	--	--	--

TABLE 6-9 (CONTINUED)
ESTIMATED AMOUNT OF WUA FOR STEELHEAD FRY AND JUVENILES IN RIVER2D USING THE MONTHLY MEAN FLOWS FROM RUSSIAN RIVER RESSIM UNDER BASELINE AND PROPOSED (INTERIM PETITIONS AND FISH FLOW PROJECT) RESERVOIR OPERATIONS

Reach	Life Stage	Monitoring Station	May	Jun	Jul	Aug	Sep	Oct	Nov
Cominsky (cont.)	Juveniles	Baseline (WUA)	6,406	6,284	6,324	6,364	6,394	6,308	6,300
		Proposed Interim Petitions (WUA)	6,218	6,049	6,124	6,189	6,241	6,139	6,283
		Proposed Interim Petitions Change (%)	-3	-4	-3	-3	-2	-3	0
		Proposed Fish Flow (WUA)	6,260	6,133	6,176	6,240	6,301	6,213	6,311
		Proposed Fish Flow Change (%)	-2	-2	-2	-2	-1	-2	0
Cloverdale	Fry	Baseline (WUA)	1,241	1,370	--	--	--	--	--
		Proposed Interim Petitions (WUA)	1,391	1,541	--	--	--	--	--
		Proposed Interim Petitions Change (%)	12	13	--	--	--	--	--
		Proposed Fish Flow (WUA)	1,367	1,487	-	-	-	-	-
		Proposed Fish Flow Change (%)	10	9	--	--	--	--	--
	Juveniles	Baseline (WUA)	7,661	7,598	7,656	7,695	7,719	7,614	7,555
		Proposed Interim Petitions (WUA)	7,455	7,308	7,425	7,504	7,560	7,421	7,535
		Proposed Interim Petitions Change (%)	-3	-4	-3	-2	-2	-3	0
		Proposed Fish Flow (WUA)	7,525	7,429	7,492	7,566	7,630	7,535	7,614
		Proposed Fish Flow Change (%)	-2	-2	-2	-2	-1	-1	1

NOTE: Dashes indicate that this life stage would not be present in the upper Russian River for these months.

SOURCE: SCWA, 2023 (unpublished data); SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

For the interim petitions, the mean monthly WUA for steelhead fry was summarized by Critical, Dry, and Normal water years over the full period of record (**Table 6-8**). During Critical years under baseline conditions the mean monthly WUA for steelhead fry ranged from 1,574 m^2 to 1,617m^2 while under the Proposed Action (interim petitions) habitat area ranged from 1,565 m^2 to 1,568 m^2. During Critical years there would be three percent less WUA in May and less than one percent more in June under the Proposed Action (interim petitions) relative to the baseline. For Dry years, habitat area for steelhead fry ranged from 1,368 m^2 to 1,391 m^2, while under the Proposed Action (interim petitions) there was a negligible change to 1,363 m^2 and 1,408 m^2. During Normal years under baseline conditions the mean monthly WUA for steelhead fry ranged from 1,286 m^2 to 1,322 m^2 while under the Proposed Action (interim petitions) habitat area ranged from 1,263 m^2 and 1,311 m^2. This represents a two percent decrease in May and one percent decrease in June under the Proposed Action (interim petitions) relative to the baseline.

TABLE 6-10
ESTIMATED AMOUNT OF WUA FOR STEELHEAD FRY AND JUVENILES IN RIVER2D USING THE MONTHLY MEAN FLOWS BY WATER YEAR TYPE FROM RUSSIAN RIVER RESSIM UNDER BASELINE AND PROPOSED (INTERIM PETITIONS) RESERVOIR OPERATIONS

Water Year	Life Stage	Monitoring Station	May	Jun	Jul	Aug	Sep	Oct	Nov
Critical	Fry	Baseline (WUA)	1,617	1,574	--	--	--	--	--
		Proposed Interim Petitions (WUA)	1,565	1,568	--	--	--	--	--
		Proposed Interim Petitions Change (%)	-3	0	--	--	--	--	--
	Juveniles	Baseline (WUA)	4,692	4,936	5,298	5,402	5,408	4,571	5,469
		Proposed Interim Petitions (WUA)	4,828	4,926	5,241	5,387	5,468	5,015	4,888
		Proposed Interim Petitions Change (%)	3	0	-1	0	1	10	-11
Dry	Fry	Baseline (WUA)	1,368	1,391	--	--	--	--	--
		Proposed Interim Petitions (WUA)	1,363	1,408	--	--	--	--	--
		Proposed Interim Petitions Change (%)	0	1	--	--	--	--	--
	Juveniles	Baseline (WUA)	5,670	5,721	5,812	5,857	5,877	5,729	5,574
		Proposed Interim Petitions (WUA)	5,665	5,656	5,771	5,825	5,853	5,705	5,597
		Proposed Interim Petitions Change (%)	-	-1	-1	-1	0	0	0
Normal	Fry	Baseline (WUA)	1,286	1,322	--	--	--	--	--
		Proposed Interim Petitions (WUA)	1,263	1,311	--	--	--	--	--
		Proposed Interim Petitions Change (%)	-2	-1	--	--	--	--	--
	Juveniles	Baseline (WUA)	5,810	5,913	5,943	5,957	5,965	5,948	5,839
		Proposed Interim Petitions (WUA)	5,687	5,892	5,932	5,951	5,960	5,938	5,859
		Proposed Interim Petitions Change (%)	-2	0	0	0	0	0	0

NOTE: Dashes indicate that this life stage would not be present in the upper Russian River for these months.

SOURCE: SCWA, 2023 (unpublished data); SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

For the Fish Flow Project, the mean monthly WUA for steelhead fry was summarized for selected back-to-back water years where stream discharge would dictate a particular Flow Schedule for that water year type under the Proposed Action (Fish Flow Project) (**Table 6-9**). For instance, WYs 1976 to 1977 would have been Flow Schedule 4 and 5, respectively. During these WYs under the Decision 1610 flow schedule the mean monthly WUA for steelhead fry ranged from 1,443 m^2 to 1,465 m^2, while under the Proposed Action (Fish Flow Project), habitat area ranged from 1,508 m^2 to 1,532 m^2. During 1976 to 1977 there would have been up to four percent more WUA under the Proposed Action (Fish Flow Project). For WYs 1987 and 1988 (Flow Schedule 3), habitat area for steelhead fry ranged from 1,267 m^2 to 1,379 m^2 under Decision 1610, while under the Proposed Action (Fish Flow Project) it was 1,433 m^2 to 1,444 m^2, yielding as much as thirteen percent more habitat under the Proposed Action (Fish Flow Project). During the WY 2008 to 2009 span, the fall of 2009 was dry relative to the period of record. The mean monthly WUA for steelhead fry in WYs 2008 through 2009 ranged from 1,261 m^2 to 1,378 m^2 using the Decision 1610 flow schedule, while under the Proposed Action (Fish Flow Project), habitat area ranged from 1,386 m^2 to 1,405 m^2. The change in WUA during 2008 to 2009 would have up to ten percent larger under the Proposed Action (Fish Flow Project). In WYs 2012 to 2013 the fall of 2013 was dry, and under the Decision 1610 flow schedule habitat area ranged from 1,267 m^2 to 1,326 m^2, while under the Proposed Action (Fish Flow Project) it ranged from 1,398 m^2 to 1,424 m^2. The increase in WUA would have been as much as ten percent.

Juveniles

The River2D model results show that under the Proposed Action (interim petitions and preliminary proposed Fish Flow Project) steelhead juvenile rearing habitat would change at all sites with a change in minimum instream flows. Model results show that steelhead juvenile WUA would increase with minimum instream flows from approximately 25 cfs to approximately 100 cfs at all sites. From approximately 100 cfs to 250 cfs, a slight increase occurs. The WUA for steelhead juveniles range from 2,167 m^2 to 7,791 m^2 depending on flow and the reach modeled (**Figure 6-11**). Under the baseline conditions, monthly median flow in the upper Russian River (estimated by Russian River ResSim at the forks of the Russian River near Ukiah, Hopland, and Cloverdale) ranged from 163 to 259 cfs from May through November.

When the River2D model results for all reaches are pooled, the mean monthly WUA for steelhead juveniles between May and November ranged from a minimum 19,984 m^2 in November to maximum of 23,683 m^2 in August for baseline conditions, and from a minimum of 19,950 m^2 in May to a maximum of 23,327 m^2 in September for flows under the interim petitions and from a minimum of 20,758 m^2 in May to a maximum of 23,504 m^2 in September for flows under the Fish Flow Project (Table 6-6), representing a small reduction in all months except October. When considered by reach, the mean monthly WUA for steelhead juveniles ranged from 3,327 m^2 in the Ukiah Reach during November to 7,719 m^2 in the Cloverdale Reach in September for baseline conditions (Table 6-7). Under the interim petitions, the mean monthly WUA by reach for steelhead juveniles ranged from 3,309 m^2 to 7,560 m^2 and under the Fish Flow Project, the mean monthly WUA by reach for steelhead juveniles ranged from 3,342 m^2 to 7,6300 m^2 for the same months and reaches. These results indicate that under the Proposed Action (both interim petitions and Fish Flow Project) there would be a small loss in juvenile steelhead rearing habitat of as much as five percent during the month of May in the Ukiah reach or as little as less than one percent in each of the reaches depending on the month.

TABLE 6-9
ESTIMATED AMOUNT OF WUA FOR STEELHEAD FRY AND JUVENILES IN RIVER2D USING THE MONTHLY MEAN BY FLOW SCHEDULE FROM RUSSIAN RIVER RESSIM UNDER BASELINE (DECISION 1610) AND PROPOSED ACTION (FISH FLOW PROJECT)

Water Year	Life Stage	Monitoring Station	May	Jun	Jul	Aug	Sep	Oct	Nov
1976 (Sched 4) – 1977 (Sched 5)	Fry	D1610 (WUA)	1,465	1,443	-	-	-	-	-
		Proposed Fish Flow Project (WUA)	1,532	1,508	-	-	-	-	-
		Change (%)	5	4	-	-	-	-	-
	Juveniles	D1610 (WUA)	5,338	5,481	5,719	5,879	5,915	5,895	5,814
		Proposed Fish Flow Project (WUA)	4,985	5,165	5,408	5,509	5,557	5,651	5,680
		Change (%)	-7	-6	-5	-6	-6	-4	-2
1987 – 1988 (Sched 3)	Fry	D1610 (WUA)	1,267	1,379	-	-	-	-	-
		Proposed Fish Flow Project (WUA)	1,433	1,444	-	-	-	-	-
		Change (%)	13	5	-	-	-	-	-
	Juveniles	D1610 (WUA)	5,966	5,772	5,851	5,883	5,914	5,886	5,750
		Proposed Fish Flow Project (WUA)	5,393	5,459	5,731	5,789	5,839	5,834	5,831
		Change (%)	-10	-5	-2	-2	-1	-1	1
2008 - 2009 (Dry Fall)	Fry	D1610 (WUA)	1,261	1,378	-	-	-	-	-
		Proposed Fish Flow Project (WUA)	1,386	1,405	-	-	-	-	-
		Change (%)	10	2	-	-	-	-	-
	Juveniles	D1610 (WUA)	5,813	5,767	5,850	5,885	5,914	5,750	5,699
		Proposed Fish Flow Project (WUA)	5,483	5,661	5,789	5,839	5,876	5,783	5,844
		Change (%)	-6	-2	-1	-1	-1	1	3
2012 – 2013 (Dry Spring)	Fry	D1610 (WUA)	1,267	1,326	-	-	-	-	-
		Proposed Fish Flow Project (WUA)	1,398	1,424	-	-	-	-	-
		Change (%)	10	7	-	-	-	-	-
	Juveniles	D1610 (WUA)	5,804	5,879	5,898	5,899	5931	5,976	5,934
		Proposed Fish Flow Project (WUA)	5,465	5,548	5,688	5,762	5,810	5,873	5,837
		Change (%)	-6	-6	-4	-2	-2	-2	-2

NOTE: Dashes indicate that this life stage would not be present in the upper Russian River for these months.

SOURCE: SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

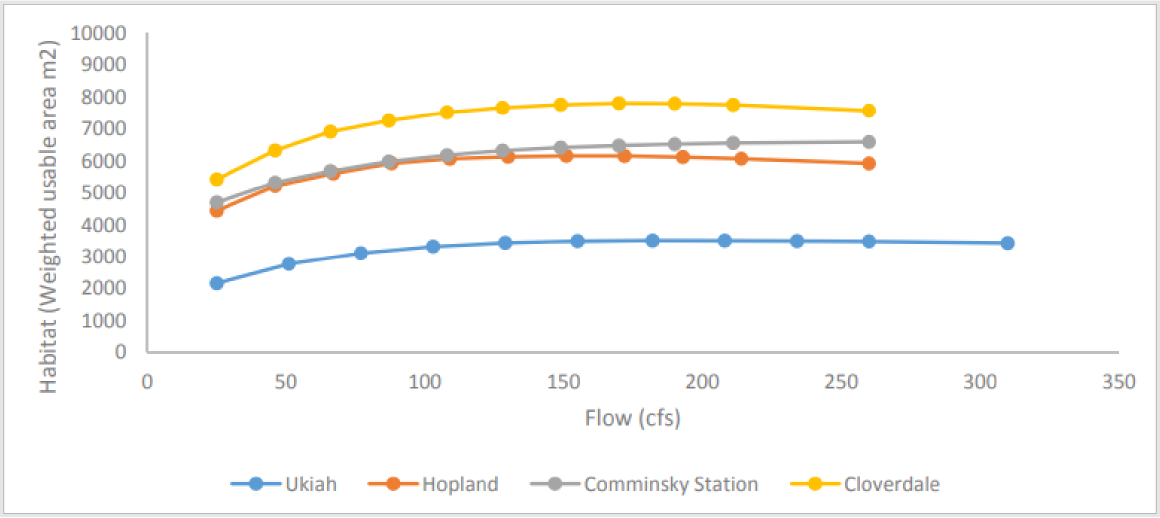

Figure 6-11
Estimated Habitat (WUA) in square meters for steelhead juveniles

For the interim petitions, the mean monthly WUA for steelhead juveniles was summarized by Critical, Dry, and Normal water years over full period of record (Table 6-8). During Critical years under baseline conditions the mean monthly WUA for steelhead juveniles ranged from 4,571 m^2 to 5,469 m^2, while under the Proposed Action (interim petitions) habitat area ranged from 4,828 m^2 to 5,468 m^2. Generally, in Critical years there would be more WUA under the Proposed Action (interim petitions) relative to the baseline, including a nine percent increase in October.

For Dry years, habitat area for steelhead juvenile ranged from 5,574 m^2 to 5,877 m^2 under the baseline, while under the Proposed Action WUA levels were very similar. During Normal years, mean monthly WUA for steelhead juveniles under the baseline conditions ranged from 5,810 m^2 to 5,965 m^2 while under the Proposed Action (interim petitions) habitat area ranged from 5,687 m^2 and 5,961 m^2. This represents a two percent decrease in May and negligible differences across the remaining months.

For the preliminary proposed Fish Flow Project, the mean monthly WUA for steelhead juveniles is summarized by selected, back-to-back water years where stream discharge would dictate that a particular Flow Schedule for that water year type under the Proposed Action would have been implemented (Table 6-9). For instance, WYs 1976 to 1977 would have been Flows Schedule 4 and 5, respectively. During these WYs under the Decision 1610 flow schedule the mean monthly WUA for steelhead juveniles ranged from 5,338 m^2 in May to 5,915 m^2 in September, while under the Proposed Action (Fish Flow Project) habitat area ranged from 4,985 m^2 in May to 5,680 m^2 in November. During 1976 to 1977 there would have been up to seven percent less WUA during the month of May under the Proposed Action (Fish Flow Project). For WYs 1987 and 1988 (Flow Schedule 3), habitat area for steelhead juveniles ranged from 5,750 m^2 in November to 5,966 m^2 in May under Decision 1610, while under the Proposed Action (Fish Flow Project) it was 5,459 m^2 in May to 5,839 m^2 in September, corresponding to as much as ten percent less WUA during the month of May. During the WY 2008 to 2009 span, the fall of 2009 was dry relative to the period of record. The mean monthly WUA for steelhead juveniles during those

WYs ranged from 5,699 m^2 in November to 5,914 m^2 in September using the Decision 1610 flow schedule, while under the Proposed Action (Fish Flow Project) habitat area ranged from 5,483 m^2 in May to 1,405 m^2 in 5,876 in September. The change in WUA during 2008 to 2009 would have up to six percent less in the month of May under the Proposed Action. In WYs 2012 to 2013 fall was of 2013 was dry, and under the Decision 1610 flow schedule habitat area ranged from 5,804 m^2 in May to 5,976 m^2 in October while under the Proposed Action (Fish Flow Project) it ranged from 5,465 m^2 in May to 5,873 m^2 in October. In WYs 2012 to 2013 the decrease in WUA would have been as much as six percent in both May and June.

Chinook Salmon

Fry

The River2D model results show that Chinook Salmon fry habitat would change at all sites with a change in minimum instream flow. At the Ukiah reach, modeled results indicate that Chinook Salmon fry WUA would slightly increase with flow from approximately 25 to 250 cfs. At the other reaches, the model results indicate that habitat would decrease with an increase in flow. The WUA for Chinook Salmon fry range from 1,072 m^2 to 3,316 m^2 depending on the flow rate and the reach modeled (**Figure 6-12**). Under baseline conditions, median flow in the upper Russian River (estimated at the forks of the Russian River near Ukiah, Hopland, and Cloverdale) range from 200 to 237 cfs during May, depending on the reach.

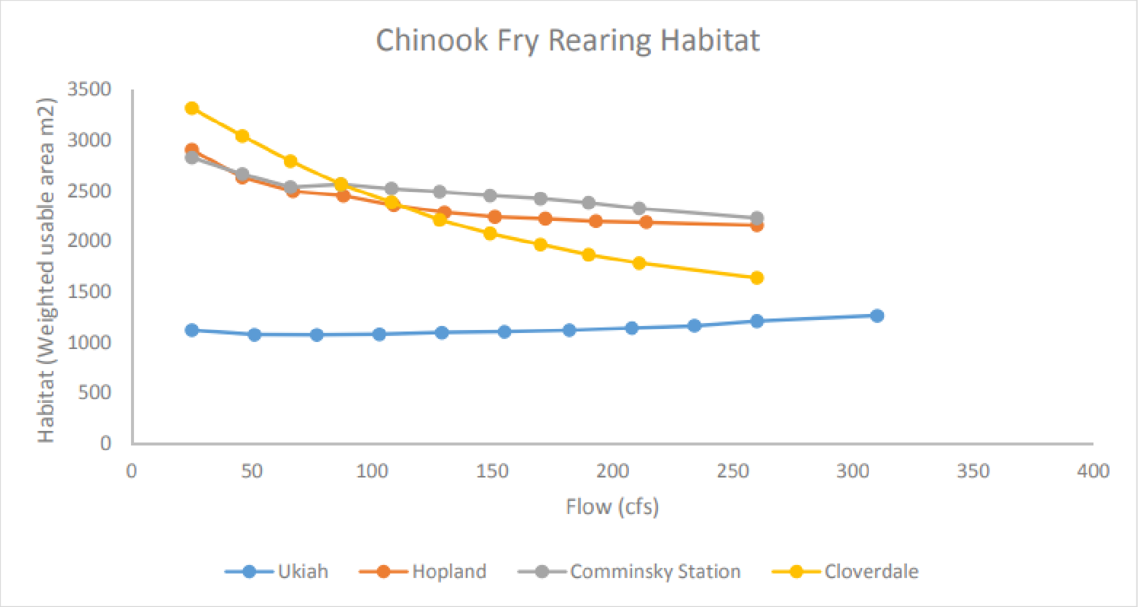

Figure 6-12
Estimated Habitat (WUA) in square meters for Chinook Salmon fry

When the River2D model results for all reaches are pooled, the mean monthly WUA for Chinook fry was 6,859 m^2 for baseline conditions and 7,236 m^2 under the interim petitions and 7,377 m^2 under the Fish Flow Project (Proposed Action) (**Table 6-10**), representing a five percent increase for interim petitions and an eight percent increase for the preliminary proposed Fish Flow Project. When considered by reach, the mean monthly WUA for Chinook fry ranged from 1,098 m^2 in the

Ukiah Reach to 2,411 m^2 in the Cominsky Reach for baseline conditions (**Table 6-11**). Under the Proposed Action, the mean monthly WUA by reach for Chinook fry ranged from 1,088 m^2 to 2,465 m^2 under the interim petitions and from 1,083 m^2 to 2,455 m^2 under the preliminary proposed Fish Flow Project. The largest increase in WUA under the Proposed Action (interim petitions) was in the Cloverdale Reach, which was ten percent larger compared to simulated flows under the baseline in May. In contrast, there was awhile there was one percent less WUA in the Ukiah Reach under the Proposed Action (interim petitions and Fish Flow Project).

For the interim petitions, the mean monthly WUA for Chinook fry was summarized by Critical, Dry, and Normal water years over full period of record (**Table 6-12**). During Critical years under baseline conditions the mean monthly WUA for Chinook fry was 2,419 m^2 under the baseline, while under the Proposed Action (interim petitions) it 2,354 m^2, a decrease of three percent. For Dry years, habitat area for Chinook fry was 2,085 m^2 under the baseline, while under the Proposed Action (interim petitions) there was a negligible decrease to 2,076 m^2. During Normal years, under baseline the mean monthly WUA for Chinook fry was 1,899 m^2 while under the Proposed Action (interim petitions) there was a three percent decrease to 1,836 m^2.

For the preliminary proposed Fish Flow Project, the mean monthly WUA for Chinook fry is summarized by selected, back-to-back water years where stream discharge would dictate that a particular Flow Schedule for that water year type would have been implemented (**Table 6-13**). For instance, WYs 1976 to 1977 would have been Flows Schedule 4 and 5, respectively. During these WYs under the Decision 1610 flow schedule the mean monthly WUA for Chinook fry was 2,224 m^2, while under the Proposed Action (Fish Flow Project) habitat area was 2,323 m^2. During 1976 to 1977 there would have been up to four percent more WUA under the Proposed Action (Fish Flow Project). For WYs 1987 and 1988 (Flow Schedule 3), habitat area for Chinook fry was 1,854 m^2 under Decision 1610, while under the Proposed Action (Fish Flow Project) it was 2,194 m^2 in September, yielding as much as eighteen percent more habitat under the Proposed Action (Fish Flow Project). During the WY 2008 to 2009 span, the fall of 2009 was dry relative compared to the period of record. The mean monthly WUA for Chinook fry during those WYs 1,818 m^2 for the Decision 1610 flow schedule, while under the Proposed Action (Fish Flow Project) habitat area was 2,106 m^2 in September. The change in WUA during 2008 to 2009 would have up to sixteen percent larger under the Proposed Action (Fish Flow Project). In WYs 2012 to 2013 fall was of 2013 was dry, and under the Decision 1610 flow schedule habitat area 1,823 m^2 while under the Proposed Action (Fish Flow Project) it was 2,136 m^2, and the increase in WUA would have been as much as nine percent.

TABLE 6-10
ESTIMATED AMOUNT OF WUA FOR CHINOOK FRY AND JUVENILES IN RIVER 2D USING THE MONTHLY MEAN FLOWS FOR RUSSIAN RIVER RESIM UNDER BASELINE CONDITIONS AND THE PROPOSED (INTERIM PETITIONS AND FISH FLOW PROJECT) RESERVOIR OPERATIONS

Reach	Life Stage	Monitoring Station	May	Jun	Jul	Aug	Sep	Oct	Nov
Russian River	Fry	Baseline (WUA)	6,859	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	7,236	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	5	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	7,377						
		Proposed Fish Flow Change (%)	8						
	Juveniles	Baseline (WUA)	14,077	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	14,329	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	2	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	14,833						
		Proposed Fish Flow Change (%)	5						

NOTE: Dashes indicate that this life stage would not be present in the upper Russian River for these months.

SOURCE: SCWA, 2023 (unpublished data); SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

TABLE 6-11
ESTIMATED AMOUNT OF WUA FOR CHINOOK FRY AND JUVENILES IN RIVER 2D USING THE MONTHLY MEAN BY RUSSIAN RIVER REACH RESIM UNDER BASELINE CONDITIONS AND THE PROPOSED (INTERIM PETITIONS AND FISH FLOW PROJECT) RESERVOIR OPERATIONS

Reach	Life Stage	Monitoring Station	May	Jun	Jul	Aug	Sep	Oct	Nov
Ukiah	Fry	Baseline (WUA)	1,098	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	1,088	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	-1	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	1,083						
		Proposed Fish Flow Change (%)	-1						

TABLE 6-11 (CONTINUED)
ESTIMATED AMOUNT OF WUA FOR CHINOOK FRY AND JUVENILES IN RIVER 2D USING THE MONTHLY MEAN BY RUSSIAN RIVER REACH RESIM UNDER BASELINE CONDITIONS AND THE PROPOSED (INTERIM PETITIONS AND FISH FLOW PROJECT) RESERVOIR OPERATIONS

Reach	Life Stage	Monitoring Station	May	Jun	Jul	Aug	Sep	Oct	Nov
Ukiah	Juveniles	Baseline (WUA)	1,631	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	1,612	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	-1	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	1,617						
		Proposed Fish Flow Change (%)	-1						
Hopland	Fry	Baseline (WUA)	2,273	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	2,370	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	4	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	2,349						
		Proposed Fish Flow Change (%)	0						
	Juveniles	Baseline (WUA)	4,381	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	4,431	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	1	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	4,453						
		Proposed Fish Flow Change (%)	2						
Cominsky	Fry	Baseline (WUA)	2,411	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	2,465	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	2	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	2,455						
		Proposed Fish Flow Change (%)	2						

TABLE 6-11 (CONTINUED)
ESTIMATED AMOUNT OF WUA FOR CHINOOK FRY AND JUVENILES IN RIVER 2D USING THE MONTHLY MEAN BY RUSSIAN RIVER REACH RESIM UNDER BASELINE CONDITIONS AND THE PROPOSED (INTERIM PETITIONS AND FISH FLOW PROJECT) RESERVOIR OPERATIONS

Reach	Life Stage	Monitoring Station	May	Jun	Jul	Aug	Sep	Oct	Nov
Cominsky	Juveniles	Baseline (WUA)	5,235	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	5,264	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	1	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	5,270						
		Proposed Fish Flow Change (%)	1						
Cloverdale	Fry	Baseline (WUA)	2,009	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	2,216	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	10	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	2,192						
		Proposed Fish Flow Change (%)	9						
	Juveniles	Baseline (WUA)	4,991	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	5,070	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	2	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	5,088						
		Proposed Fish Flow Change (%)	2						

NOTE: Dashes indicate that this life stage would not be present in the upper Russian River for these months.

SOURCE: SCWA, 2023 (unpublished data); SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

TABLE 6-12
ESTIMATED AMOUNT OF WUA FOR CHINOOK FRY AND JUVENILES IN RIVER 2D USING THE MONTHLY MEAN BY WATER YEAR TYPE RESIM UNDER BASELINE CONDITIONS AND THE PROPOSED (INTERIM PETITIONS) RESERVOIR OPERATIONS

Water Year	Life Stage	Monitoring Station	May	Jun	Jul	Aug	Sep	Oct	Nov
Critical	Fry	Baseline (WUA)	2,419	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	2,354	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	-3	-	-	-	-	-	-
	Juveniles	Baseline (WUA)	4,057	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	4,060	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	0	-	-	-	-	-	-
Dry	Fry	Baseline (WUA)	2,085	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	2,076	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	0	-	-	-	-	-	-
	Juveniles	Baseline (WUA)	4,160	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	4,145	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	0	-	-	-	-	-	-
Normal	Fry	Baseline (WUA)	1,899	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	1,836	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	-3	-	-	-	-	-	-
	Juveniles	Baseline (WUA)	3,943	-	-	-	-	-	-
		Proposed Interim Petitions (WUA)	3,784	-	-	-	-	-	-
		Proposed Interim Petitions Change (%)	-4	-	-	-	-	-	-

NOTE: Dashes indicate that this life stage would not be present in the upper Russian River for these months.

SOURCE: SCWA, 2023 (unpublished data); SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

TABLE 6-13
ESTIMATED AMOUNT OF WUA FOR CHINOOK FRY AND JUVENILES IN RIVER 2D USING THE MONTHLY MEAN BY WATER YEAR TYPE RESIM UNDER BASELINE (DECISION 1610) AND THE PROPOSED ACTION (FISH FLOW PROJECT)

Water Year	Life Stage	Monitoring Station	May	Jun	Jul	Aug	Sep	Oct	Nov
1976 (Sched 4) – 1977 (Sched 5)	Fry	D1610 (WUA)	2,224	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	2,323	-	-	-	-	-	-
		Change (%)	4	-	-	-	-	-	-
	Juveniles	D1610 (WUA)	4,160	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	4,118	-	-	-	-	-	-
		Change (%)	-1	-	-	-	-	-	-
1987 – 1988 (Sched 3)	Fry	D1610 (WUA)	1,854	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	2,194	-	-	-	-	-	-
		Change (%)	18	-	-	-	-	-	-
	Juveniles	D1610 (WUA)	3,936	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	4,177	-	-	-	-	-	-
		Change (%)	6	-	-	-	-	-	-
2008 - 2009 (Dry Fall)	Fry	D1610 (WUA)	1,818	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	2,106	-	-	-	-	-	-
		Change (%)	16	-	-	-	-	-	-
	Juveniles	D1610 (WUA)	3,795	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	4,097	-	-	-	-	-	-
		Change (%)	8	-	-	-	-	-	-
2012 – 2013 (Dry Spring)	Fry	D1610 (WUA)	1823	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	2136	-	-	-	-	-	-
		Change (%)	17	-	-	-	-	-	-
	Juveniles	D1610 (WUA)	3,787	-	-	-	-	-	-
		Proposed Fish Flow (WUA)	4,138	-	-	-	-	-	-
		Change (%)	9	-	-	-	-	-	-

NOTE: Dashes indicate that this life stage would not be present in the upper Russian River for these months.

SOURCE: SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

Juveniles

The River2D model results show that WUA for Chinook Salmon juveniles would increase with instream flow from approximately 25 to 70 cfs at all sites. From approximately 70 to approximately 250 cfs, a slight decrease occurs. The WUA for Chinook Salmon juveniles range from 1,331 m^2 to 5,358 m^2 depending on flow and the reach modeled (**Figure 6-13**).

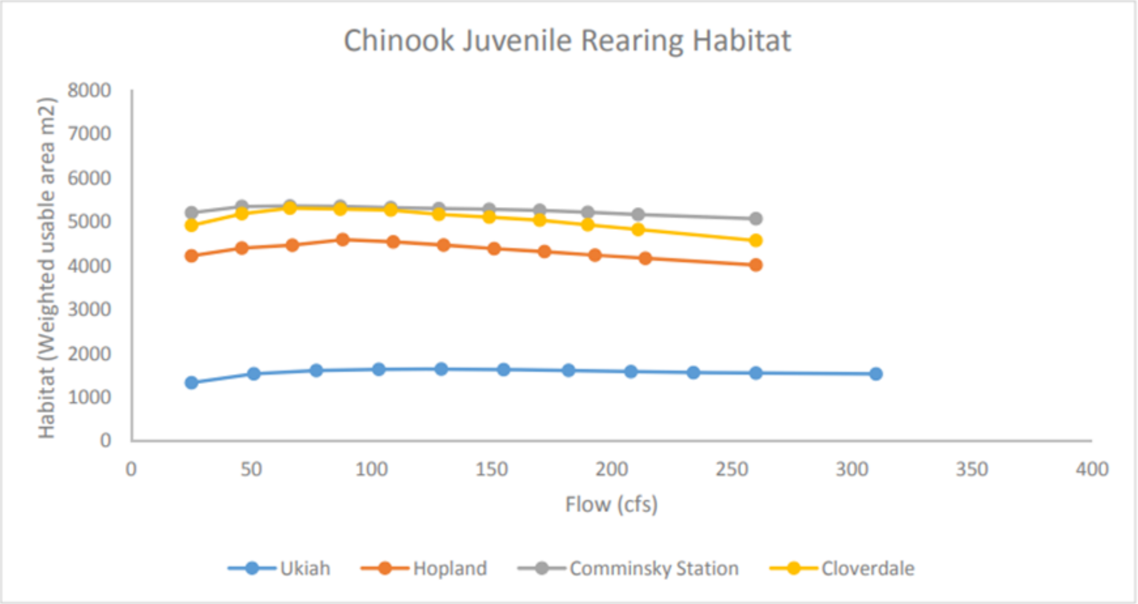

Figure 6-13
Estimated Habitat (WUA) in square meters for Chinook Salmon juveniles

When the River2D model results for all reaches are pooled, the mean monthly WUA for Chinook juveniles was 14,077 m^2 for baseline, and was 14,329 m^2 for flows under the interim petitions and 14,833 m^2 under the preliminary proposed Fish Flow Project (Proposed Action). Proposed Action (Table 6-9), representing a five percent increase under the Proposed Action. When considered by reach, the mean monthly WUA for Chinook juveniles 1,631 m^2 in the Ukiah Reach to 5,235 m^2 in the Cominsky Reach for the baseline (Table 6-10). Under the Proposed Action, the mean monthly WUA by reach for Chinook juveniles was 1,612 m^2 to 5,264 m^2 under the interim petitions and 1,617 m^2 to 5,270 m^2 under the preliminary proposed Fish Flow Project, for the same months and reaches (Table 6-10). Under the interim petitions the largest increase in WUA was in the Cloverdale Reach, which was two percent larger compared to baseline, under the preliminary Fish Flow Project there was a two percent increase in WUA at the Hopland and Cloverdale reaches. Conversely, there was a slight decrease in WUA within the Ukiah Reach at one percent under both the interim petitions and preliminary proposed Fish Flow Project.

For the interim petitions, the mean monthly WUA for Chinook juveniles was summarized by Critical, Dry, and Normal water years over full period of record (Table 6-10). During Critical years under the baseline the mean monthly WUA for Chinook juveniles was 4,057 m^2 under the baseline and 4,060 under the Proposed Action (interim petitions). For Dry years, habitat area for Chinook juveniles was 4,160 m^2 under the baseline, while under the Proposed Action (interim petitions) there was a negligible decrease to 4,145 m^2. During Normal years, under the baseline the mean monthly WUA for Chinook juveniles was 3,943 m^2 while under the Proposed Action (interim petitions) there was a four percent decrease to 3,784 m^2.

For the preliminary proposed Fish Flow Project, the mean monthly WUA for steelhead juveniles is summarized by selected, back-to-back water years where stream discharge would dictate that a particular Flow Schedule for that water year type would have been implemented (Table 6-11). For instance, WYs 1976 to 1977 would have been Flow Schedules 4 and 5, respectively. During these WYs under the Decision 1610 flow schedule the mean monthly WUA for Chinook juveniles 4,160 m^2, while under the Proposed Action (Fish Flow Project) habitat area was 4,118 m^2, representing a one percent decrease. For WYs 1987 and 1988 (Flow Schedule 3), habitat area for Chinook juveniles was 3,936 m^2 under Decision 1610, while under the Proposed Action (Fish Flow Project) it was 4,177 m^2, yielding six percent more habitat under the Proposed Action (Fish Flow Project). During the WY 2008 to 2009 span, the fall of 2009 was dry compared to the period of record. The mean monthly WUA for Chinook juveniles during those WYs 3,795 m^2 using the Decision 1610 flow schedule, while under the Proposed Action (Fish Flow Project) habitat area 4,097 m^2, an eight percent increase. In WYs 2012 to 2013 fall was of 2013 was dry, and under the Decision 1610 flow schedule habitat area 3,787 m^2 while under the Proposed Action (Fish Flow Project) it was 4,138 m^2, which is nine percent larger.

Adult Passage

Adult salmon require a particular stream depth suitable to access their spawning grounds and successfully spawn. In the Russian River, adult Chinook Salmon spawn on riffles primarily in the upper Russian River and in Dry Creek. Coho Salmon spawn in tributaries to the Russian River and Dry Creek the bulk of which are located downstream of Healdsburg. Steelhead spawn in the tributaries to the Russian River and Dry Creek as well as in the upper mainstem Russian river, and in Dry Creek. Minimum depths that allow for adult salmonid passage are not well defined in the literature and will be discussed further in this section. River depth is largely a function of flow. The lowest flow that still creates depths suitable for fish passage is often referred to as a “passage flow.” Sonoma Water used three lines of evidence to identify passage flows in the Russian River by 1) surveying the depths of shallow riffles in the Russian River; and 2) verifying that adult salmonids could pass these sections of river by operating an underwater video camera upstream of these riffles; and 3) conducting Chinook Salmon spawning surveys during periods of low flow to confirm that salmonids successfully accessed their spawning grounds.

Minimum stream depths at which adult salmonids can successfully migrate have received little attention in the literature. The most cited criterion is the Oregon Department of Fish and Wildlife’s (formerly the Oregon State Game Commission) criterion of 0.8 feet for suitable passage conditions for Chinook Salmon.[469] Thompson (1972) suggests that passage is unimpeded when the shallowest riffle in a river has a riffle crest that is at least 0.8 feet deep. However, this does not provide insight into depths where migration is impeded or prevented. Thompson’s criterion was based on measurements of fish morphology and not observations of fish behavior. Salmonids have been observed moving upstream at shallower depths.[470],[471] A study in the Eel River

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[469] Thompson, Ken. 1972. *Op. cit.*

[470] Mosely, M. P. 1982. "Critical depths for passage in braided rivers, Canterbury, New Zealand." New Zealand Journal of Marine and Freshwater Research 16 (3-4): 351-357.

[471] USGS. 2005. "Instream Flow Characterization of Upper Salmon River Basin Streams, Central Idaho, 2005 Scientific Investigations." Report 2006–5230. Prepared in cooperation with the Bureau of Reclamation U.S., United States Geological Service.

found that Chinook could access spawning grounds above rifles with a maximum riffle crest depth of 0.6 feet.[472] USGS (2005) concluded that the Thompson criterion was too restrictive and opted to follow Scott et al. (1981) and selected 0.6 feet as a minimum depth suitable for Chinook Salmon passage.[473] They noted that Chinook Salmon have been observed migrating through water as shallow as 0.2 feet deep.[474] Sonoma Water has documented Chinook Salmon upstream of riffles that failed to meet the Thompson Criterion as well. In the Russian River, shallow areas (less than 0.8 feet deep) tend to be very short in linear distances, and would not require a significant effort by an adult Chinook Salmon to traverse to deeper water.

To address concerns about reduced flow conditions during a dry period, Sonoma Water conducted surveys to investigate the spawning success of adult salmonids in 2013.[475] In total 29.8 river kilometers of stream were surveyed to identify and measure shallow riffles that may delay or prevent upstream migration by Chinook Salmon in 2013-14. The entire lower Russian River from Mirabel to Cassini Ranch was surveyed by kayak in order to identify the shallowest riffles downstream of Mirabel. Concurrent with the kayak-based surveys, Sonoma Water conducted adult Chinook Salmon counts at the Mirabel fish ladders, located at rkm 40.2, and used these observations to provide an estimate of river flow needed for Chinook Salmon to reach the ladders. Sonoma Water surveyed the river upstream of the Mirabel fish ladders to confirm that Chinook Salmon reached spawning sites. At a subset of these spawning sites, Sonoma Water collected additional depth and velocity information to describe stream conditions. Sonoma Water focused on Chinook Salmon because they are, on average, the largest salmonid in the river and would require the greatest depth for migration.

Over 20 riffles were measured for these surveys and Sonoma Water found that many shallow riffles (max depth less than 1 foot) occur over observed flows, ranging from 75-115 cfs measured at the nearest USGS stream gage. The four shallowest riffles were located at Casini Ranch near Duncans Mills, at Monte Rio, at Badger Park near Healdsburg, and Geyserville (near Hwy 128) (Table 6-7).[476] In 2015, a shallow riffle was measured in the lower Alexander Valley reach which was not surveyed in 2013. The deepest part of the riffle crest was 0.7 feet deep when measured on September 15, 2015 at a flow of 83 cfs (measured at the USGS Jimtown gage) (**Table 6-14**).

TABLE 6-14
LOCATION AND MAXIMUM DEPTH AT THE RIFFLE CREST OF THE SHALLOWEST RIFFLES MEASURED DURING SHALLOW RIFFLE SURVEY IN THE RUSSIAN RIVER

Location	Max Depth (ft.)	Stream Gage	Flow	Note
Cassini Ranch	0.6	Hacienda	90	
Monte Rio	1.1	Hacienda	75	River Mouth Closed

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[472] VTN. 1982. Potter Valley Project (FERC No. 77) Fisheries Study Final Report Volume II Appendices. Willsonville: VTN.

[473] VTN. 1982. Potter Valley Project (FERC No. 77) Fisheries Study Final Report Volume II Appendices. Willsonville: VTN.

[474] USGS. 2005. *Op. cit.*

[475] Smith, J.P. 2013. Russian River Chinook migration and spawning 2013. Santa Rosa: Sonoma County Water Agency.

[476] SCWA, 2014. Unpublished Data. Russian River and Dry Creek spawner surveys conducted between 2008 and 2014. Contact: David Cook, Senior Environmental Specialist, Sonoma County Water Agency.

Location	Max Depth (ft.)	Stream Gage	Flow	Note
Monte Rio	0.8	Hacienda	90	River Mouth Open
Badger Park	0.6	Diggers Bend	80	
Geyserville	0.7	Cloverdale	114	
Geyserville	0.6	Cloverdale	48	
Alexander Valley	0.7	Jimtown	83	

SOURCE: SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

A flow of 130 cfs at the USGS Hacienda stream gage in the lower Russian River provides depths suitable for salmonid passage. Relatively few Chinook Salmon were observed at the Mirabel fish ladder at flows less than 125 cfs at Hacienda. However, flows below 125 cfs at Hacienda occur infrequently during the Chinook migration season. Large numbers of Chinook Salmon (up to 213 and 589 in a day) have been observed at Mirabel when flow at Hacienda was 130 to 135 cfs. At this flow riffles downstream of Mirabel would be at least 0.6 ft. deep.

Sonoma Water conducted spawner surveys in the upper Russian River and noted observed that a flow of 110 cfs measured at the USGS stream gage at Healdsburg provides depths sufficient for salmonid passage in the upper river. Chinook were observed as far upstream as Hopland during a period of time when flow had not exceeded 110 cfs at Healdsburg for over 75 days. Furthermore, Chinook adults were observed in Alexander Valley, and Hopland reaches when flow did not exceed 110 cfs from September 1, 2013, to November 12 and 14, 2013, when Chinook were observed in the upper Russian River.[477] River when flow is 110 cfs measured at USGS stream gage at Healdsburg.

In 2014, kayak-based adult Chinook spawner surveys were conducted in Dry Creek from WSD to the USGS stream gage at the mouth of Dry Creek. During the period of October 23 through November 25, 2014, flow ranged from 59 to 98 cfs at the mouth of Dry Creek. In total, 128 Chinook redds and 11 adult Chinook Salmon were observed. Of the 128 Chinook redds observed, 78 were observed in the upper 1/2 of Dry Creek (upstream of Lambert Bridge). Riffle depths were not measured during these surveys, but observations of Chinook redds indicate that adult Chinook can access Dry Creek spawning areas during flows as low as 98 cfs at the mouth of Dry Creek.

Field surveys to assess riffle crest depth and adult Chinook presence provide information on flow requirements to achieve adult salmonid passage in mainstem Russian River (upper and lower reaches) and Dry Creek. Observed minimum flow requirements for each reach are summarized in **Table 6-15**.

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[477] Smith, J.P. 2013. *Op. cit.*

TABLE 6-15
SALMONID PASSAGE FLOWS IN THE RUSSIAN RIVER

Reach	Stream Gage	Passage Flows (cfs)
Upper Russian River	Healdsburg	110
Lower Russian River	Hacienda	135
Dry Creek	Mouth of Dry Creek	90

SOURCE: SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

Under baseline conditions adult Chinook Salmon passage flows occur frequently. Chinook Salmon enter the Russian River and begin staging in the Estuary in October, but in most years the bulk of the upstream migration occurs from October 15 through December. Chinook Salmon spawning habitat is in the upper Russian River and in Dry Creek, but Chinook Slamon Salmon must also traverse the lower Russian River to access these spawning areas. Under baseline conditions, flows are sufficient for Chinook Salmon upstream migration for 64% to 98% of the time varying both temporally and spatially (**Table 6-16**).

TABLE 6-16
PERCENT OCCURRENCES OF PASSAGE FLOWS FOR CHINOOK SALMON UNDER BASELINE CONDITIONS

Reach	Stream Gage	Passage Flows (cfs)	Oct 15-31	Nov	Dec
Upper Russian River	Healdsburg	110	64%	82%	93%
Lower Russian River	Hacienda	135	86%	95%	98%
Dry Creek	Mouth of Dry Creek	90	98%	96%	97%

SOURCE: SCWA, 2023 (unpublished data)

Adult Coho Salmon passage flows also occur frequently under baseline conditions. Coho Salmon spawning habitat is mainly located in tributaries to the lower Russian River and tributaries to Dry Creek, although some spawning may occur in mainstem Dry Creek. Upstream of Healdsburg, there is limited spawning habitat in a few tributaries to the Russian River. While most of the Coho spawning habitat is located outside of the action area, Coho must traverse the lower Russian River and Dry Creek, and to a lesser extent the upper Russian River in order to access their spawning habitat. While Coho Salmon may stage in the Russian River Estuary as early as October, the Coho adult migration period is generally from November to February. Under the baseline condition, flows are sufficient for Coho Salmon upstream migration for 82% to 98% of the time. The percent of time that Coho Salmon can migrate upstream varies temporally and spatially (**Table 6-17**).

TABLE 6-17
PERCENT OCCURRENCES OF PASSAGE FLOWS FOR COHO SALMON UNDER BASELINE CONDITIONS

Reach	Stream Gage	Passage Flows (cfs)	Nov	Dec	Jan	Feb
Upper Russian River	Healdsburg	110	82%	93%	97%	97%
Lower Russian River	Hacienda	135	95%	98%	98%	98%
Dry Creek	Mouth of Dry Creek	90	96%	97%	89%	95%

SOURCE: SCWA, 2023 (unpublished data)

Under baseline conditions steelhead are able to access their spawning grounds relatively frequently. Most steelhead spawning habitat is located in the tributaries to the Russian River and in tributaries to Dry Creek. Some steelhead spawn in the upper Russian River near Hopland and in the mainstem of Dry Creek. To access these habitats steelhead must be able to move upstream through the lower Russian River, the upper Russian River, and through Dry Creek. The steelhead migration period is from December through March. The percent of the time upstream migration flows are sufficient for steelhead varies by month and by location, but in general steelhead can access their spawning grounds 89% to 100% of the time under baseline conditions (**Table 6-18**).

TABLE 6-18
PERCENT OCCURRENCES OF PASSAGE FLOWS FOR STEELHEAD UNDER BASELINE CONDITIONS

Reach	Stream Gage	Passage Flows (cfs)	Dec	Jan	Feb	Mar
Upper Russian River	Healdsburg	110	93%	97%	97%	99%
Lower Russian River	Hacienda	135	98%	98%	98%	100%
Dry Creek	Mouth of Dry Creek	90	97%	89%	95%	99%

SOURCE: SCWA, 2023 (unpublished data)

Spawning

Adult salmonids require adequate depth and velocity to construct viable redds. Depth and velocity are reliant on the quantity of flow in a river. Sonoma Water used a two-dimensional habitat model of depths and velocities in the upper Russian River and related these to Chinook and steelhead preferences in order to estimate the quantity of spawning habitat in the upper Russian River at different flows. Sonoma Water also conducted salmonid spawning surveys in the upper Russian River and in Dry Creek to document the success of adult salmon spawning.

Based on habitat modeling Chinook and steelhead spawning habitat is present in sufficient quantities when flow in the Russian River is approximately 130 cfs at Healdsburg. Adult salmon spawning habitat suitability criteria have not been constructed for the Russian River; however, Chinook and steelhead spawning habitat suitability criteria from other rivers (e.g., Clear Creek) are available in the literature.[478]

Sonoma Water collected bathymetric data at Ukiah, Hopland, Comminsky Station, and Cloverdale for a complementary study.[479] In past years the Hopland, Comminsky Station, and Cloverdale reaches were not used (or used very infrequently) by adult Chinook and steelhead for spawning, therefore these reaches were excluded from the analysis of adult spawning habitat.[480] In general, habitat modeling at the Ukiah reach indicated that the amount WUA of Chinook and steelhead spawning habitat increased with an increase in flow up to approximately 130 cfs at Healdsburg after which little additional Chinook or steelhead spawning habitat became available with an increase of flow.[481] Observations from spawning surveys in the upper Russian River support the model results, that a flow of 130 cfs provides depth and velocity conditions which are suitable for Chinook Salmon spawning.

Studies conducted in the Russian River have identified flows that provide spawning habitat conditions (depth and velocity) for adult Chinook Salmon. Based on habitat modeling and spawner surveys, a flow of approximately 130 cfs when measured at Healdsburg provides spawning habitat throughout the upper Russian River. These flows are likely conservative as Chinook may spawn at lower flows. Since steelhead are smaller than Chinook and spawn in smaller substrate flows of 130 cfs should be more than adequate to provide spawning habitat in the upper Russian River. Coho are also smaller than Chinook and would be able to spawn at similar flows.

Under baseline conditions flows that allow for suitable spawning conditions occur frequently. The Chinook Salmon spawning season begins in November and continues through February. Flows are sufficient for spawning 72 to 97% of the time and vary temporally and spatially (**Table 6-19**). The steelhead spawning season occurs between December and March. During this time flows are sufficient for steelhead spawning 72 to 99% of the time based on Russian River ResSim modeling results (Table 6-18).

TABLE 6-19
PERCENT OCCURRENCE OF SPAWNING FLOWS FOR CHINOOK SALMON AND STEELHEAD BASED ON RUSSIAN RIVER RESSIM MODELING RESULTS

Reach	Gage	Spawning Flow	Nov	Dec	Jan	Feb	Mar
Upper Russian River	Healdsburg	130	72%	86%	97%	97%	99%

SOURCE: SCWA, 2023 (unpublished data); SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

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[478] Gard, M.F. 2011. Flow-habitat relationships for fall-run Chinook salmon and steelhead/rainbow trout spawning in Clear Creek between Clear Creek Road and the Sacramento River. Sacramento: U.S. Fish and Wildlife Service.

[479] SCWA, 2016. *Op. cit.*

[480] Cook, D.G. 2008. "Chinook salmon spawning study, Russian River Fall 2002-2007." Sonoma County Water Agency, Santa Rosa, CA.

[481] SCWA. 2016. *Op. cit.*

6.2.1.2 Species Effects

Juvenile Rearing

Steelhead

Fry

The changes in minimum instream flow may have a beneficial effect on the quantity of rearing habitat for steelhead fry in the upper Russian River. Instream flows in the upper Russian River would decrease from May through June leading to an average overall increase in the total amount of rearing habitat for steelhead fry when all reaches are combined together, providing a net benefit in the upper Russian River. However, this response is variable depending on the reach. Over the entire period of record, Cloverdale and Cominsky reaches showed larger average increases in habitat from May through June, while Hopland and Ukiah showed smaller average decreases in habitat. However, despite the variability, the overall impact of flow reductions would be a net benefit for fry rearing when all reaches are taken together. When considering the impacts of changes to instream flow across water year types, steelhead fry will experience benefits from changes under the proposed project. This is related to an increased amount of slow water habitat which is a direct result of reduced instream flow from May through June.

Enhancing the quantity and quality of steelhead rearing habitat throughout this segment, would occur in conjunction with conserving the cold-water pool in Lake Mendocino. Conservation of that cold-water pool would increase the likelihood that water released from that reservoir would remain suitably cool for rearing steelhead throughout the summer.

Juveniles

For juvenile steelhead, the changes to minimum instream flow will have a beneficial effect on the quantity of rearing habitat in May and November, and minimal negative effects from June through October. On average, decreased discharge under the proposed changes in June through October would lead to an overall decrease in habitat quantity. Similar to the findings for steelhead fry, this relationship is variable depending on reach. For the Hopland and Ukiah reaches, May through June show a reduction in juvenile habitat with minimal reduction from July through October. Alternatively, Cloverdale and Cominsky show habitat reduction from May through November with the largest reductions in habitat seen from June to September. However, these habitat losses are negated by corresponding gains in other reaches leading to an overall net benefit for juvenile steelhead in May and November, and a minimal deficit from June through October. When considering the impacts of changes to instream flow across the water year type, steelhead juveniles experience a net loss in habitat, following the general trends seen in river-wide and reach-specific assessments.

Chinook Salmon

Fry

Minimum instream flows in the upper Russian River would decrease in May under the Proposed Action and likely provide an increase in the amount of rearing habitat for Chinook Salmon fry. Similar to steelhead fry, reduced flows in May under the Proposed Action will lead to an increase in suitable rearing habitat when all reaches are combined. There is some variability in habitat quantity when evaluated by reach, with Cloverdale seeing the largest benefit and Ukiah seeing the only deficit. These reach-specific effects result in a net benefit to Chinook Salmon fry under the Proposed Action. When considering the impacts of changes to instream flow across water year types, Chinook Salmon fry would experience slight decreases in habitat in Critical and Dry years.

Juveniles

Minimum instream flows in the upper Russian River would decrease during May under the Proposed Action and therefore provide increase in the amount of rearing habitat for Chinook Salmon juveniles would occur. As with Chinook Salmon and steelhead fry, reduced flows lead to an overall increase in suitable rearing habitat when all reaches are combined. The same variability in reach-specific habitat exists for Chinook Salmon juveniles as for Chinook Salmon fry, with Cloverdale, Cominsky, and Hopland reaches seeing an increase in available habitat while Ukiah sees a slight decrease. Overall, the reach-specific effects again result in a net benefit to juvenile Chinook Salmon under the Proposed Action.

Adult Passage

To assess potential effects of the Proposed Action (interim petitions and Fish Flow Project) on adult upstream movement, the passage condition was analyzed by comparing the percentage of time flows sufficient to allow for the upstream passage of adult salmonids were modeled to occur during the upstream migration period for each of the three species analyzed under the Proposed Action. Passage flows for the lower Russian River are 135 cfs at Hacienda. For the upper Russian River, passage flows are 110 cfs at Healdsburg. In Dry Creek, passage flows are 90 cfs at the mouth of Dry Creek.

Upper Russian River

The Proposed Action largely provides largely suitable conditions for adult passage for the months of October and November and remains relatively similar to baseline conditions for the months January through March (**Table 6-20**). Reductions in passage flows during October, November, and December are the result of changes to the minimum instream flow program the Proposed Action's objective to reduce adverse effects from high water velocities on rearing (and maintaining cold-water pool in the reservoir for longer into the rearing season) (see Section 3.2.2.1, *Interim Seven-year Petitions to Decision 1610*). These reductions, while beneficial to rearing fish, would result in reductions in passage flows during the early portions of the migration period. However, the peak of the migration period would be largely unaffected.

TABLE 6-20
PERCENT OCCURRENCE OF UPSTREAM MIGRATION FLOWS IN UPPER RUSSIAN RIVER AT HEALDSBURG GAGE

Scenario	Passage Flows (cfs)	Oct 15-31	Nov	Dec	Jan	Feb	Mar
Baseline	110	64%	82%	93%	97%	97%	99%
Proposed Interim Petitions	110	41%	78%	89%	97%	97%	99%

SOURCE: SCWA, 2023 (unpublished data).

Lower Russian River

Salmonid passage flows in the lower Russian River remain suitable for the Proposed Action (**Table 6-20**). Under the Proposed Action, there would be a significant decrease for the months of October and November, with minimal decreases in December and January. Instream conditions remain relatively the same for the months February and March. As with the upper Russian River, reductions in the occurrence of passage flows are the result of changes minimum instream releases the Proposed Action's objective to better protect rearing habitat for steelhead.

TABLE 6-21
PERCENT OCCURRENCE OF UPSTREAM MIGRATION FLOWS IN LOWER RUSSIAN RIVER AT HACIENDA GAGE

Scenario	Passage Flows (cfs)	Oct 15-31	Nov	Dec	Jan	Feb	Mar
Baseline	135	86%	95%	98%	98%	98%	100%
Proposed Interim Petitions	135	42%	80%	94%	97%	98%	100%

SOURCE: SCWA, 2023 (unpublished data.

TUCO Adult Passage Monitoring

Fisheries monitoring and reporting as part of TUCOs typically requires Sonoma Water to record the daily number of adult salmonids moving upstream during the period of instream flow reduction. Beginning October 1 if the mouth of the river is open and adult salmon and steelhead can enter the Russian River, Sonoma Water conducts adult salmonid spawning surveys in representative reaches in Dry Creek and in the upper Russian River (above Healdsburg, CA) on a weekly basis continuing through the duration of the order or until sustained flow at Hacienda (USGS gage 11467000) is above 135 cfs.

Recent monitoring of adult upstream passage coincident with periods of instream flow reduction suggests that reductions in river flow below 125 cfs during the migration season have a negligible impact on adult upstream movement. For much of the adult migration period, flows in the lower river remain above 135 cfs (Hacienda) and above 105 cfs in the upper river (Healdsburg) for the latter half of the adult migration period. When flows were below 135 cfs in the lower river and below 105 cfs in the upper river, water temperature is often unfavorable for adult salmonids (the month of September) or the river mouth is closed and blocking upstream movement of adult salmonids (most of October).[482,483]

Spawning

The quantity of upper Russian River spawning habitat is analyzed by comparing the percentage of time that flows sufficient to allow for salmonid spawning are modeled to occur during the spawning period for each species under the Proposed Action, compared to baseline conditions. Flows suitable for spawning in the upper Russian River are 130 cfs at Healdsburg. The Proposed Action would slightly increase the frequency of passage flows in some months slightly decrease in other; all changes would be three percent or less and are not expected to result in adverse effects on spawning salmonids(**Table 6-22**). Overall, the Proposed Action should provide suitable spawning conditions in the upper Russian River.

TABLE 6-22
PERCENT OCCURRENCE OF SPAWNING FLOWS IN THE UPPER RUSSIAN RIVER NEAR HEALDSBURG

Scenario	Spawning Flow (cfs)	Nov	Dec	Jan	Feb	Mar
Baseline	130	72%	86%	97%	97%	99%
Proposed Interim Petitions	130	73%	83%	94%	97%	99%

SOURCE: SCWA, 2023 (unpublished data).

TUCO Adult Spawning Monitoring

As described above, Sonoma Water is often tasked with conducting salmonid spawning surveys during the duration of instream flow reduction as part of TUCO monitoring requirements. To accomplish this, Sonoma Water staff visit spawning grounds in Dry Creek and the mainstem Russian River periodically while an Order is in place.

Monitoring during the 2020 TUCO confirmed the presence of spawning fish during the period of instream flow reduction. More extensive spawning ground surveys were conducted in Dry Creek and the mainstem river during the weeks of December 3 and December 10. During these more extensive surveys 115 redds were observed during the week of December 3 and 23 redds were observed during the week of December 10 (**Table 6-23**).[484]

The number of Chinook redds observed during spawner surveys was relatively low in 2020. However, the number of returning adults was low in 2020 so it was expected that fewer redds would be encountered. It is unlikely that the low adult returns and observed redds during 2020 were the result of reductions in minimum instream flows since previous reductions in instream flow have not resulted in reduced redd counts.

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[484] Sonoma Water, 2021. *Op. cit.*

TABLE 6-23
SALMON REDD OBSERVATIONS AND FLOW IN THE LOWER RIVER (HACIENDA) AND UPSTREAM OF DRY CREEK (HEALDSBURG) 2020

Week	Redd Counts	Flow (cfs)	
	Chinook	Hacienda	Healdsburg
1-Oct	0	88-91	80-84
8-Oct	0	90-99	78-88
15-Oct	0	78-86	71-81
22-Oct	0	79-84	70-78
29-Oct	0	90-116	74-79
5-Nov	0	114-140	78-90
12-Nov	3	145-202	92-108
19-Nov	4	165-210	106-116
26-Nov	4	162-169	104-113
3-Dec	115*	156-168	109-112
10-Dec	23*	159-236	110-142
17-Dec	5	202-280	121-170
24-Dec	6	196-319	117-189
31-Dec	9	238	150

NOTE:
* Kayak based surveys were conducted on these days. They cover more spawner sites in a day than walk-in surveys.
SOURCE: Sonoma Water, 2021. SWRCB Order 7/28/2020. Term 2 – Fisheries Monitoring Tasks.

6.2.2 Warm Springs Dam (Dry Creek)

6.2.2.1 Habitat Effects

Juvenile Rearing

Prior to issuance of the *2008 Biological Opinion*, Dry Creek was primarily used by Chinook Salmon and steelhead for rearing habitat, with limited potential to support Coho Salmon. ENTRIX (2003) found that Dry Creek provided minimal habitat for Coho Salmon.[485] This study was conducted when minimum instream flows in Dry Creek were managed in accordance with the Sonoma Water's water right permits and Decision 1610. In the *2008 Biological Opinion,* NMFS concluded that the continued operations of WSD by USACE and Sonoma Water in a manner similar to recent historic practices are likely to jeopardize and adversely modify critical habitat for Coho Salmon and steelhead. Thus, both the interim petitions and Fish Flow Project (Proposed Action) include alterations to the hydrologic index and minimum instream releases (consistent with the *2008 Biological Opinion* for interim petitions) to address the impact of the existing minimum flow regime on instream habitat for salmonids.

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[485] NMFS, 2008. *Op. cit.*

Adult Passage

A discussion of adult passage requirements within the lower Russian River and at the mouth of Dry Creek for Chinook Salmon, Coho Salmon, and steelhead is contained above under Section 6.2.1, *Adult Passage.* Based on adult Chinook Salmon spawning surveys, including an assessment of riffle depth, the minimum instream flow requirements for adult upstream passage at the Dry Creek mouth is 90 cfs.

Spawning

In Dry Creek a flow of 90 cfs at the USGS gage at the mouth of Dry Creek is likely more than adequate to provide suitable depths and velocities for Chinook spawning. Surveys in 2014 found Chinook could access and spawn in Dry Creek at flows ranging from 91 to 98 cfs at the mouth of Dry Creek, although lower flows may provide spawning habitat as well. Therefore, a flow of 90 cfs when measured at the mouth of Dry Creek is likely more than sufficient to provide suitable depths and velocities for Chinook Salmon spawning. Because steelhead are smaller than Chinook Salmon and spawn in smaller substrate, flows of 90 cfs should be more than adequate to provide spawning habitat in Dry Creek. Coho are also smaller than Chinook and would be able to spawn at similar flows.

Under baseline conditions, flows that allow for suitable spawning conditions occur frequently. The Chinook Salmon spawning season begins in November and continues through February. Flows are sufficient for spawning 89 to 97% of the time and vary temporally (**Table 6-24**). Coho spawning occurs from December through February. During this time the frequency that spawning flows occur in Dry Creek ranges from 89 to 97% of the time and varies by month (Table 6-23). The steelhead spawning season occurs between December and March. During this time flows are sufficient for steelhead spawning 89 to 99% of the time based on Russian River ResSim modeling results (Table 6-24).

TABLE 6-24
PERCENT OCCURRENCE OF SPAWNING FLOWS FOR COHO SALMON AND STEELHEAD BASED ON RUSSIAN RIVER RESSIM MODELING RESULTS

Reach	Gage	Spawning Flow	Nov	Dec	Jan	Feb	Mar
Dry Creek	Mouth of Dry Creek	90	96%	97%	89%	95%	99%

SOURCE: SCWA, 2023 (unpublished data); SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

6.2.2.2 Species Effects

Juvenile Rearing

Changes in minimum instream flows from implementation of the Proposed Action are not expected to decrease the amount of rearing habitat for steelhead, Chinook Salmon or Coho Salmon in Dry Creek. Baseline monthly median flows in Dry Creek are fairly similar to those found under the Proposed Action, ranging from 90 cfs to 399 cfs depending on the month under baseline conditions, and from 96 to 399 cfs under the Proposed Action (**Table 6-25**). From May through November, when flows are mainly determined by reservoir releases, monthly median flows range from 90 to 115 cfs under baseline conditions. Monthly median flows would range from 96 cfs to 129 cfs under the proposed action during this period. The slight changes in instream flows would result in negligible effects on the quantity of rearing habitat for steelhead, Chinook Salmon or Coho Salmon in Dry Creek.

TABLE 6-25
MONTHLY MEDIAN FLOWS (CFS) ESTIMATED BY RUSSIAN RIVER RESSIM FOR THE MOUTH OF DRY CREEK UNDER BASELINE CONDITIONS AND THE PROPOSED ACTION (INTERIM PETITIONS)

Alternative	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baseline	305	399	326	172	107	90	90	90	90	90	115	161
Proposed Interim Petitions	305	399	325	172	102	97	122	136	129	96	115	115

SOURCE: SCWA, 2023 (unpublished data); SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

Under higher flow conditions (WSD releases of 110 to 160 cfs prior to the completion of Dry Creek habitat enhancements affording improved habitat conditions), it is possible for rearing juvenile salmonids to be swept downstream. While habitat enhancements in Dry Creek counteract this effect by creating high flow refugia, the potential still remains. Based on the modeled median monthly summer flow releases, Sonoma Water and the USACE expects the following flow threshold exceeding events during the next seven years (the time prior to the completion of Dry Creek habitat enhancements affording improved habitat conditions for WSD releases of 110 to 160 cfs):

- monthly median flow immediately below WSD during low flow months (June, July, August, September, and October) exceeds 160 cfs in more than 6 months of the total 35 low flow months (five months per year for 7 years) covered by the first 7 years of this consultation period;
- monthly median flow immediately below WSD during low flow months (June, July, August, September, and October) exceeds 140 cfs in more than 17 months of the total 35 low flow months (five months per year for 7 years) covered by the first 7 years of this consultation period;
- monthly median flow immediately below WSD during low flow months (June, July, August, September, and October) exceeds 120 cfs in more than 10 months of the total 35 low flow months (five months per year for 7 years) covered by the first 7 years of this consultation period, and
- monthly median flow immediately below WSD during low flow months (June, July, August, September, and October) exceeds 105 cfs in more than 20 months of the total 35 low flow months covered by the first 7 years of this consultation period.

After the completion of Dry Creek habitat enhancements, it is expected that good habitat conditions would be maintained for higher WSD releases (up to 160 cfs). Based on the modeled median monthly summer flow releases, Sonoma Water and the USACE expects the following flow threshold exceeding events during the final three years (assuming that the remaining habitat enhancements described in the Proposed Action are implemented and shown to be effective and support good production of juvenile steelhead and Coho Salmon by end of Year 7):

- monthly median flow immediately below WSD during low flow months (June, July, August, September, and October) exceeds 160 cfs in more than 3 months during Years 8-10 covered by this consultation period (assuming that the remaining habitat enhancements described in the Proposed Action are implemented and shown to be effective and support good production of juvenile steelhead and Coho Salmon by end of Year 7).

Adult Passage

Passage flows in Dry Creek would remain suitable with implementation of the proposed action. Under the Proposed Action, there would be a significant decrease for the months of October through December. Instream conditions remain relatively the same for the months January through March. Reductions in the occurrence of passage flows are the result of changes in minimum instream releases to better protect rearing habitat for steelhead. These changes could affect early migrating Chinook Salmon, however, the majority of the peak migration period for steelhead and Coho Salmon would be unaffected by this change. Overall, the Proposed Action, would still provide suitable conditions for the movement or migration of salmonids in Dry Creek (**Table 6-26**).

TABLE 6-26
PERCENT OCCURRENCE OF UPSTREAM MIGRATION FLOWS IN DRY CREEK AT DRY CREEK GAGE

Scenario	Passage Flows (cfs)	Oct 15-31	Nov	Dec	Jan	Feb	Mar
Baseline	90	98%	96%	97%	89%	95%	99%
Proposed Interim Petitions	90	82%	71%	77%	88%	95%	99%

SOURCE: SCWA, 2023 (unpublished data); SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

Spawning

The quantity of Dry Creek spawning habitat is analyzed by comparing the percentage of time that flows sufficient to allow for salmonid spawning are modeled to occur during the spawning period for each species under each of the three alternatives compared to baseline conditions. Dry Creek flows suitable for spawning are 90 cfs at the mouth of Dry Creek. The suitable conditions needed by salmonids for spawning habitat would remain relatively unchanged for the months of January through March. However, there would be significant reductions in spawning flows during the months of November and December (**Table 6-27**). These differences are result of reductions in minimum instream flows under the interim petitions and Fish Flow Project to reduce the effects of high-water velocities on spawning and rearing fish. While these reductions could reduce the availability of spawning habitat in the early portion of the spawning period, the majority of the spawning period and areas where spawning occurs would be unaffected. As such, minimal impact on the spawning condition of Dry Creek is expected to occur under the Proposed Action (both interim petitions and preliminary proposed Fish Flow Project).

TABLE 6-27
PERCENT OCCURRENCE OF SPAWNING FLOWS IN THE DRY CREEK AS MEASURED NEAR MOUTH OF DRY CREEK

Scenario	Spawning Flow (cfs)	Nov	Dec	Jan	Feb	Mar
Baseline	90	95%	97%	90%	96%	100%
Proposed Interim Petitions	90	71%	77%	88%	95%	99%

SOURCE: SCWA, 2023 (unpublished data); SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

6.2.3 Estuary

6.2.3.1 Habitat Effects

As described in Section 3.2.2, *Water Supply Operations*, NMFS concluded in the *2008 Biological Opinion* that the continued operations of CVD and WSD in a manner similar to recent historic practices are likely to jeopardize and adversely modify the critical habitats of endangered Coho Salmon and steelhead. Specifically, NMFS concluded that the artificially elevated summertime minimum flows in the Russian River and Dry Creek that are currently required by the Decision 1610 minimum flow requirements result in high water velocities that reduce the quality and quantity of rearing habitat for Coho Salmon and steelhead. Additionally, NMFS concluded that maintaining these flows disrupts lagoon formation and retention in the Russian River Estuary and that allowing a lagoon to develop and remain during the summer would likely enhance juvenile steelhead and salmon habitat. The *2008 Biological Opinion* also determined that artificially high inflows into the Russian River Estuary interfere with the normal processes that discharge river flow through or over the barrier beach to the ocean and that changing minimum instream flow requirements would enhance the prospects of enhancing salmonid estuarine rearing habitat.

Minimum instream flows under baseline and the Proposed Action (interim petitions and preliminary proposed Fish Flow Project) have a limited effect on the Estuary condition (open or closed) for much of the year. Russian River inlet closure events have occurred in all months of the year, but tend to be most common in spring and fall months. Spring closures tend to be short (one to two weeks in duration) and fall closures tend to last longer; owing to lower river discharge in the fall. During the late-fall to late-spring period, with some variability depending on water year or season type, flows that enter the Estuary (as measured at the Hacienda USGS gauge) are well above the Lake Sonoma releases into Dry Creek. The relationship of streamflow at the Hacienda gage to Lake Sonoma releases and minimum instream flow requirements are shown for multiple water year types in **Figures 6-14 through 6-16**.

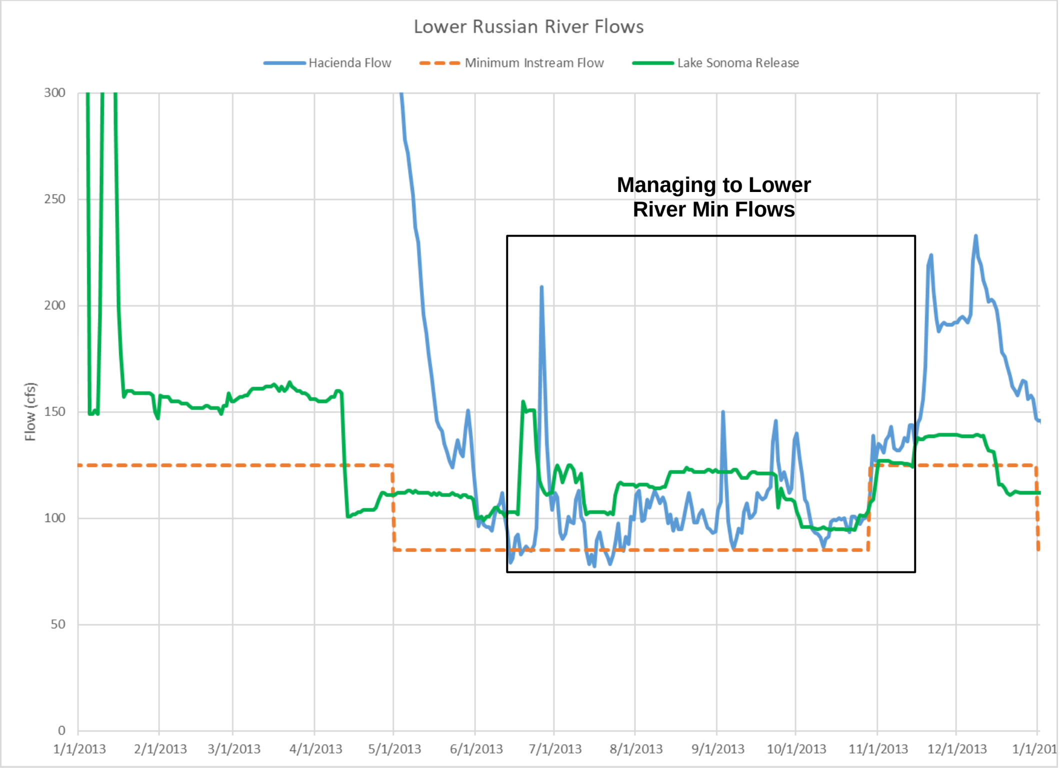

Figure 6-14
Lower Russian River Streamflow – 2013 (Dry Spring year type)

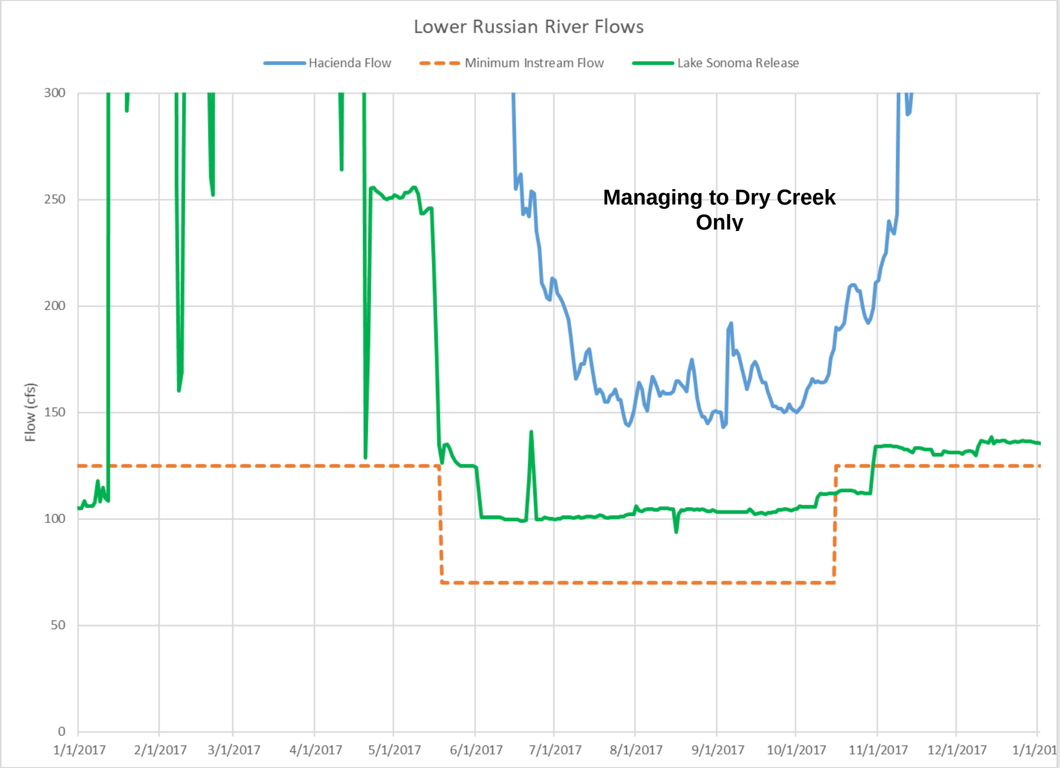

Figure 6-15
Lower Russian River Streamflow – 2017 (Normal year type)

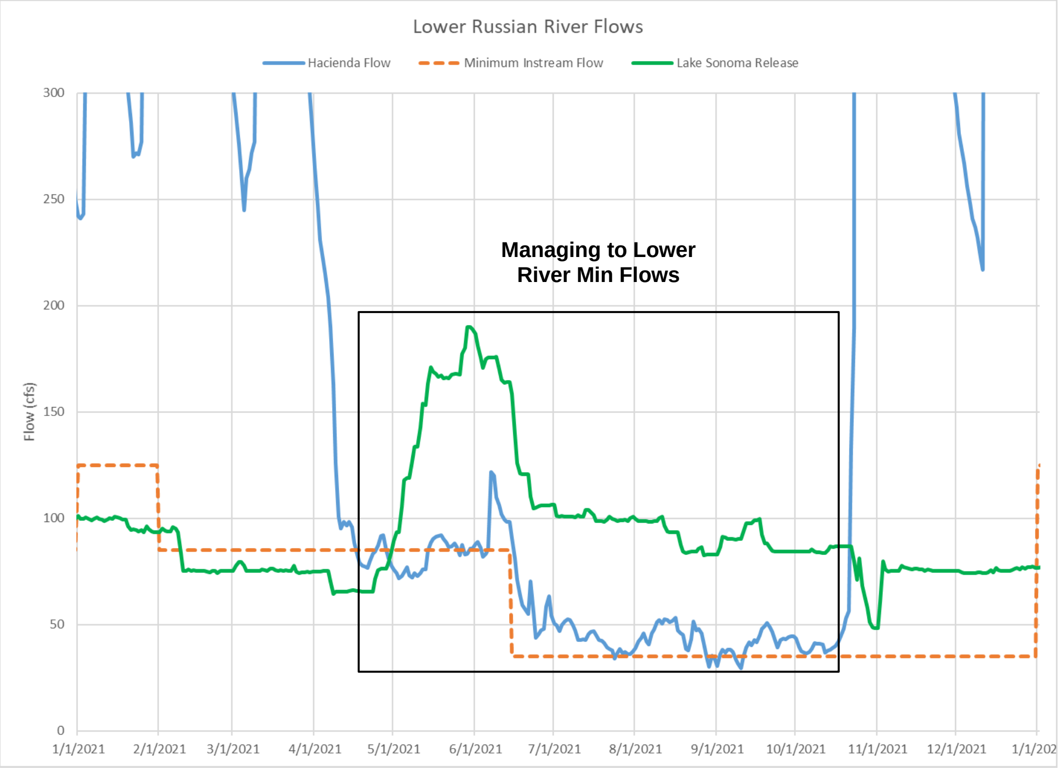

Figure 6-16
Lower Russian River Streamflow – 2021 (Critical year type)

Since a substantial portion of the Russian River watershed occurs downstream of the reservoirs, much of the lower river is supplied via ground- and surface-water runoff that is not regulated by Lake Sonoma. As such, Sonoma Water's water supply and minimum instream flow releases has little influence on the Estuary condition (i.e., the ability to encourage or maintain closures) for much of the year. Furthermore, the incitement of closure is not particularly sensitive to river flows; tides and waves play a larger role. However, instream flows can influence the duration of closure, since instream flows determine the rate of rise of Estuary water surface elevation once closed. For a discussion of Russian River Estuary state dynamics please see Section 4.3.7, *Russian River Estuary*.

During the summer and early-fall period, minimum instream flows have greater influence on flows entering the Estuary, particularly in dry or critically dry years or seasons. Importantly, in normal or wet years minimum instream flow requirements have little influence on the condition of the Estuary for the entire water year. In drier years, when closure events in late-summer and early-fall due to increased wave energy, minimum instream flows may result in lower inflows into the Estuary and prolong closure events (e.g., fall 2021 closure).

6.2.3.2 Species Effects

Proposed minimum instream flow requirements under Proposed Action, interim petitions and the proposed preliminary Fish Flow Project are not anticipated to change the frequency that the barrier beach forms or water quality conditions. However, lowering minimum instream flow requirements in the mainstem Russian River will result in lower inflows. Lower inflows may decrease the frequency that the closed Estuary reaches water surface elevations that would or require beach management in order to minimize flood risk to low-lying properties in the summer months. These effects come with the anticipated benefit of enhancing the quantity and quality of rearing habitat for steelhead.

Lower inflows into the Estuary may prolong the duration of inlet closures which may delay adult salmonid migration in the early part of the fall migration period, especially in drier water years. Adult salmonids may be delayed from entering the Estuary if closures extend into November and December. Importantly, thermal conditions are typically unsuitable in the upper Estuary for adult salmonids before mid-October. During most years, flow in the Russian River is controlled by releases from project reservoirs for much of the adult salmon migration season. Under these conditions, the mouth of the river may be closed for most of October and periodically in November and December. However, the mouth is typically sufficiently open to allow for upstream migration by adult salmonids. Monitoring data collected as part of the TUCO suggest that even in years when the mouth is closed periodically in October, there exists a sufficient window for adult salmonids to enter the Estuary. Importantly, the Proposed Action will consider access for migrating adults when determining if breaching is appropriate during the fall period. To protect the adult migration period, beach management actions could be implemented, in coordination with NMFS and CDFW, to allow adults access if conditions in the river are appropriate (see Section 3.4.1, *Beach Management*).

Since adult Chinook Salmon immigrate the earliest of the three salmonid runs they are most likely to have the immigration timing affected. The peak immigration periods for Coho Salmon and steelhead adults occur later in the year, from November onward, and overlap more frequently with open beach conditions. Thus, water supply operations are expected to have a negligible effect on Coho Salmon and steelhead adult immigration. Sonoma Water monitoring of adult Chinook immigration at Mirabel confirms that adults are able to delay entering the Estuary until conditions allow and opportunistically immigrate during beach openings.

6.2.4 Water Quality

6.2.4.1 Water Temperature

Water temperature directly affects an organism's ability to survive, grow, and reproduce. Within a species-specific tolerance range, as water temperature increases, growth rate and other metabolic activities also increase. Water temperatures above or below this range may result in an increased susceptibility to disease and predation, a reduction in swimming performance, and a reduction in growth rates. Ultimately, excessively low or high temperatures can result in direct mortality (excessively low temperatures do not occur in Russian River and will not be discussed). Factors such as dissolved oxygen levels, food availability, and exposure to predation and diseases, influence the effects of temperature on fish growth and survival. The effects of water temperature vary by life stage (e.g., embryos are less tolerant of high temperatures than juveniles) and by the ecological variable being considered (e.g., disease resistance versus maximum growth rates). The significance of this is clear when considering the potential impacts associated with different ecological variables impinging on a population. Impacts associated with diseases are reduced at very cold temperatures. Conversely, growth is maximized at relatively warm temperatures. Larger fish are more competitive with smaller conspecifics, are better able to avoid predation, and have higher overall survival rates. Thus, maximizing temperature for one variable (e.g., resistance to disease) may decrease the suitability of another variable (e.g., growth).

Water temperatures naturally vary on a daily and seasonal basis, and are seldom within the optimal range for a particular species for extended periods of time. This is particularly true for the Russian River, which is located near the southern edge of the range for coastal salmonids. Further, habitat conditions vary depending on position in the watershed. The significance of this fact on the distribution of fish communities within a river system is that some reaches of the Russian River would not provide suitable summer rearing habitat for salmonids under natural conditions. This is borne out by the fact that several warm water species (e.g., hardhead, Sacramento pikeminnow, and Sacramento sucker) thrived in the Russian River prior to water management activities in the watershed.[486,487]

Critical temperatures that limit production and survival of salmonids vary widely in the literature. Verhille et al. (2016) found that steelhead living in the lower Tuolumne River maintained 95% of peak aerobic scope between 64 and 76°F.[488] Their results suggested that the Tuolumne River population may be locally adjusted to its river system, and that it may not be appropriate to apply criteria developed from geographically disparate systems. Although thermal criteria developed from more northern (and often from snowmelt driven systems) was used out of necessity, it is possible that salmonids in the Russian River, like those in the Tuolumne River, may tolerate warmer temperatures compared to salmonids from colder climes where much of the water temperature data were developed. For example, McCullough et al. (1999) site data suggesting that the ability of steelhead to smolt is impaired at temperatures between 53.5 and 55.5° F while other studies reported that steelhead smolts were negatively affected at temperatures above 59.0° F.[489] However, in 2016, the daily average water temperature recorded at the USGS stream gauge at Hacienda exceeded 55.5° F on February 11 at a flow of 407 cfs, and exceeded 59° F on April 3 at a flow of 179 cfs. This suggest that Russian River steelhead are either able to complete the smoltification process at higher temperatures, or that they complete the smoltification process in tributaries and are able to travel to the Pacific Ocean before suffering ill effects of warm water.

Much of the literature analyzing the effects of temperature on fish is focused on determining “optimal” or lethal levels. However, even in pristine environments, fish often spend the majority of their time exposed to “suboptimal” conditions. Fish are able to survive, grow, and reproduce at temperatures above their theoretical “optimum.” Sullivan et al. (2000) modified Brett (1956)

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[486] USFCC. 1892. Part XVL. Report to the Commissioner for 1888 (Jul 1, 1888 - June 30 1889. Salmon Fisheries of the Pacific Coast. Washington D.C.: Government Printing Office.

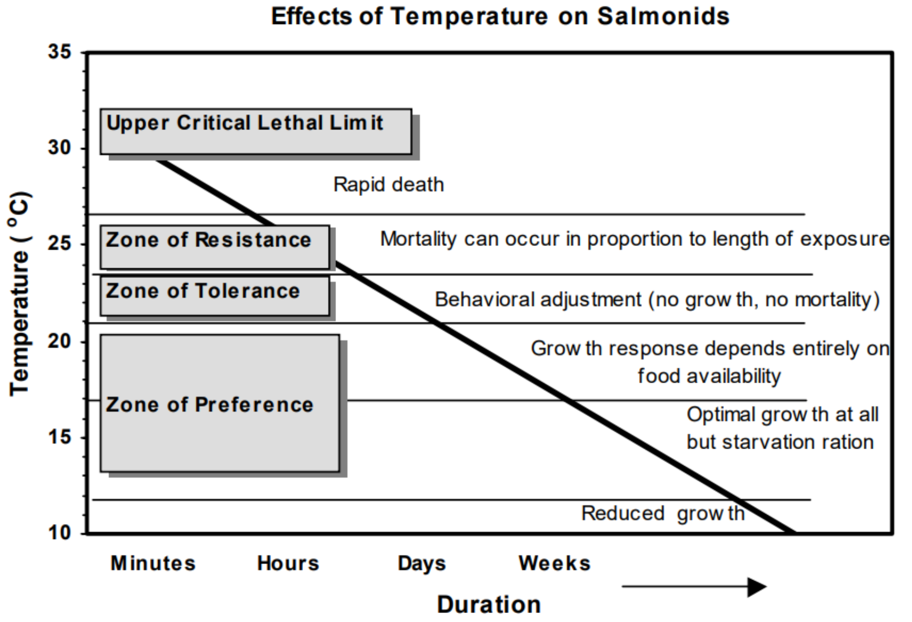
[487] Snyder, J O. 1908. "The fauna of Russian River, California, and its relation to that of the Sacramento." Science 685: 269-271.

[488] Verhille CE, English KK, Cocherell DE, Farrell AP, Fangue NA. 2016. High thermal tolerance of a rainbow trout population near its southern range limit suggests local thermal adjustment. Conserv Physiol 4(1): cow057; doi:10.1093/conphys/cow057.

[489] McCullough, D, S Spalding, D Sturdevant, and M Hicks. 1999. Summary of technical literature examining the physiological effects of temperature on salmonids. Prepared as part of the EPA Region 10 temperature water quality criteria guidance development project, U.S. Environmental Protection Agency.

generalized concept of the effects of temperature on salmonid.[490] They used four categories (zones) with five physiological responses to relate the effects of temperature on growth and survival (**Figure 6-17**). There are two responses within the “Zone of Preference;” “optimal” conditions where survival is maximized, and growth occurs at all but starvation rations; and “suitable” temperatures where survival is high and growth occurs proportional to food availability. Within the “Zone of Tolerance,” fish are becoming stressed; while mortality does not increase, growth may be compromised based on the length of exposure. Within the Zone of Resistance, fish are highly stressed. Survival and growth are decreased proportional to exposure. At the upper critical lethal limit, death occurs rapidly.

A key point in understanding thermal related impacts on fish is that they form a continuum that is influenced by both the actual temperature and the length of exposure. Exposure to very high temperatures for short periods of time can increase the rate of mortality; conversely, exposure to moderate warm temperatures for an extended period of time can result in negative impacts to growth and survival as well.



SOURCE: adapted from Sullivan et al. 2000.

Figure 6-17
Effects of Temperature on Salmonids in relation to Duration and Magnitude

Temperature Criteria

Definitive criteria to assess the effects of temperature on fish are not available in the literature. Further, the effects of temperature on some life stages of each of the three listed species have been poorly studied, requiring the use of data from related species. All of this presents a dilemma for assessing the effects of modifying minimum instream flow requirements and its resultant

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[490] Sullivan, K., Martin, D.J., J.E. Cardwell, J.E. Toll, and S. Duke. 2000. An analysis on the effects of temperature on salmonids of the Pacific Northwest with implications for selecting temperature criteria. Sustainable Ecosystem Institute.

effect on temperature on fish. Analyzing the average temperature between alternatives is instructive to assess the overall effect of changing flows; however, in some cases, small changes in temperature can have profound impacts to fish. Developing such a metric is complicated by the interactions of multiple variables (e.g., life stage, food availability, DO, disease, etc.) over the range of temperatures that fish can survive. In addition, recent studies suggest that fish may become adapted to local conditions and may tolerate a much wider range of temperatures than generally reported in the literature. In addition, the influence of water temperature occurs over a continuum, with the effects ranging from “ideal” slowly degrading to lethal.

Although observational data are available for Chinook Salmon, Coho Salmon, and steelhead in the Russian River, and continuous water temperatures measurements have been collected on the Russian River: there have been no site-specific water temperature studies on salmonids conducted in this watershed. The following temperature criteria was based on a review of the literature, in combination with observations of salmonids in the Russian River watershed (**Tables 6-28** through **6-30**).

TABLE 6-28
WATER TEMPERATURE (°F) ASSESSMENT CRITERIA FOR CHINOOK SALMON BY LIFESTAGE

Scenario	Adult Migration (Oct 1 – Dec 31)	Spawning and Egg Incubation (Nov 16 – Mar 31)	Juvenile Rearing (Apr 1 – Jun 30)	Smolt Emigration (Apr 1 – Jun 30)
Optimal	≤60.0	53.5	62.5	≤62.5
Suitable	60.1 - 64.0	53.5 - 58.0	62.6 - 64.0	61.1 - 64.0
Tolerance	64.1 - 67.0	58.1 - 60	64.1 - 68.0	63.6 - 68.0
Resistance	67.1 - 74.9	60.1 - 64.0	68.1 - 74.9	68.1 - 74.9
Lethal	≥75.0	>64.0	≥75	≥75

SOURCE: Sonoma Water (2016).

TABLE 6-29
WATER TEMPERATURE (°F) ASSESSMENT CRITERIA FOR COHO SALMON BY LIFESTAGE

Scenario	Adult Migration (Nov 1 – Feb 28)	Spawning and Egg Incubation (Dec 1 – Mar 31)	Juvenile Rearing (Apr 1 – Nov 30)	Smolt Emigration (Mar 1 – May 31)
Optimal	≤52.0	≤50.0	≤57.0	≤50
Suitable	52.1 - 59.0	50.1 - 53.0	≤62.5	50.1 - 57.0
Tolerance	59.1 - 70.0	53.1 - 54.5	62.5 - 64.0	57.1 - 62.5
Resistance	70.1 - 74.9	54.6 - 57.0	64.1 - 74.9	62.6 - 74.9
Lethal	≥75	>57.1	≥75	≥75

SOURCE: Sonoma Water (2016).

TABLE 6-30
WATER TEMPERATURE (°F) ASSESSMENT CRITERIA FOR STEELHEAD BY LIFESTAGE

Scenario	Adult Migration (Dec 1 – Mar 31)	Spawning and Egg Incubation (Dec 1 – Apr 30)	Juvenile Rearing (Apr 1 – Nov 30)	Smolt Emigration (Mar 1 – May 31)
Optimal	≤52.0	≤52.0	≤62.5	≤52
Suitable	52.1 - 59.0	52.1 - 59.0	62.5 - 66.0	52.1 - 55.0
Tolerance	59.1 - 70.0	59.1 - 60.0	66.1 - 71.4	55.1 - 59
Resistance	70.1 - 74.9	60.1 - 64.0	71.5 - 74.9	59.1 - 74.9
Lethal	≥75	>64.0	≥75	≥75

SOURCE: Sonoma Water (2016).

Modeling Results

A water quality model of the Russian River was developed using HEC 5Q to simulate how changes in flow affect water temperature and dissolved oxygen in Lakes Mendocino and Sonoma, Dry Creek, and the Russian River downstream of Warm Springs and Coyote Valley dams. As described above, simulated flow for baseline conditions and the Proposed Action (interim petitions) were generated using the Russian River Reservoir Simulation Model (Russian River ResSim) and used as input into the water quality model. Water temperature was not modeled under the preliminary proposed Fish Flow Project but future revisions to the ResSim will include incorporation of an analysis of the Fish Flow Project on water temperature. Meteorological conditions were based upon California Irrigation Management Information System (CIMIS) data from stations at Hopland and Santa Rosa for 1989 to 2017. The model was calibrated using water quality field observations from 1990 to 2005. Further validation of the model was completed in 2015 using data from 2000 to 2017.[491] Water temperature and DO levels were modeled at the Russian River ResSim nodes as well as 3 km and 6 km downstream from the confluence of the east and west forks of the Russian River, at Geyserville, and at Lambert Bridge (Dry Creek) to assess the potential for the Proposed Project (interim petitions) to affect these parameters (**Figure 6-18**).

The potential for changes in water temperature to affect listed salmonids for each life stage are assessed using two primary metrics.

1. The mean maximum daily temperatures (over the 107-year period of record) are presented to provide an overview of thermal conditions under the baseline and Proposed Action (interim petitions).
    a. The mean maximum daily temperature was selected as the primary metric to evaluate adverse effects on salmonids since effects associated with sub-lethal temperatures are difficult to quantify. Additionally, warmer temperatures than prescribed in the literature may be suitable

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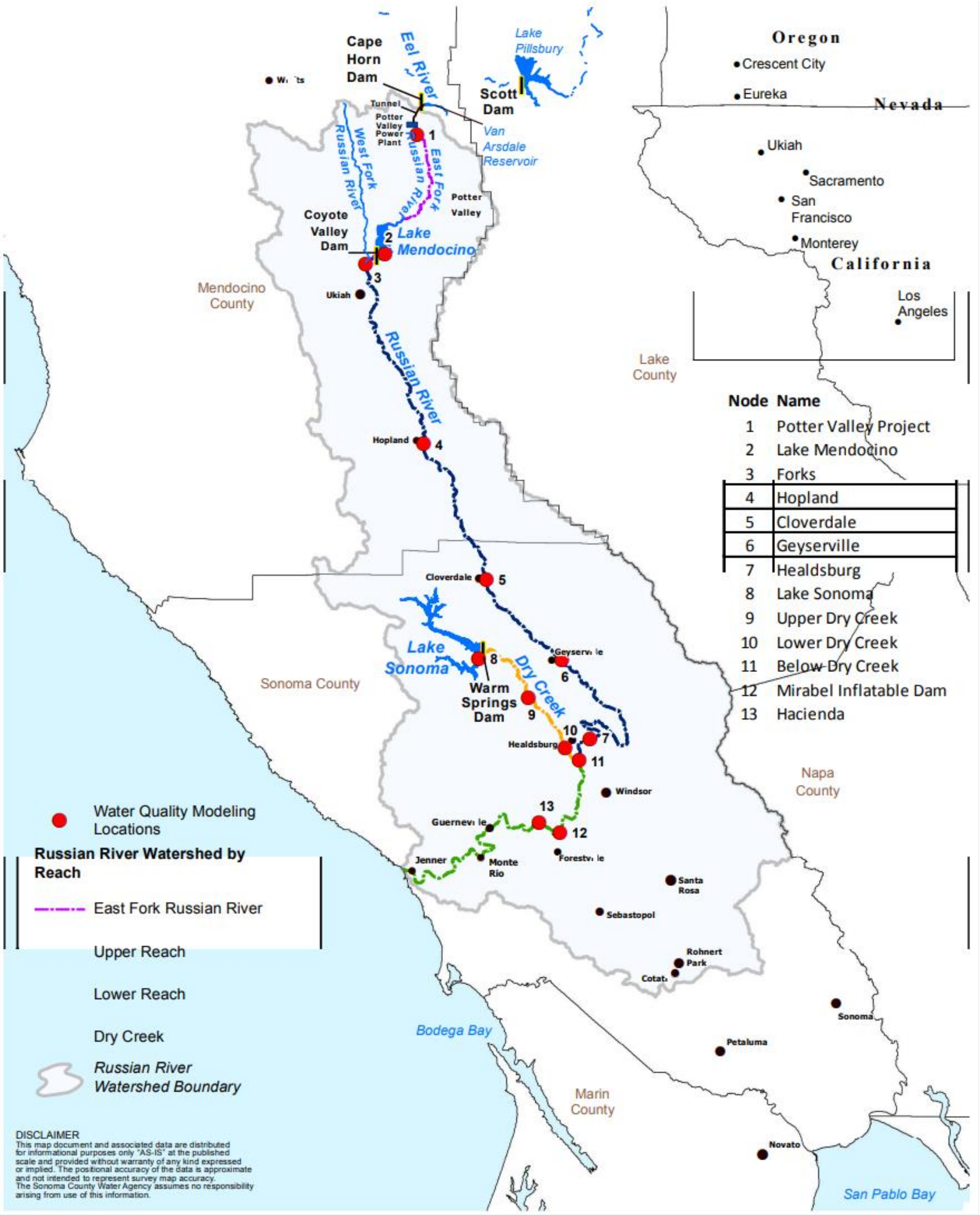
[491] The HEC 5Q water quality model is described in further detail in Appendix G of the Fish Flow DEIR (https://evogov.s3.amazonaws.com/185/media/165217.pdf).
Note: the ResSim Model period of record was updated to include water years 2014 through 2017 since the development of the model for purposes of the Fish Flow DEIR.

to different Russian River salmonid life stages. As such, lethal limits provide a good threshold for bracketing severe effects on salmonids from the Proposed Action.

2. The proportion of days by month water temperature exceeded the lethal threshold by location and scenario.

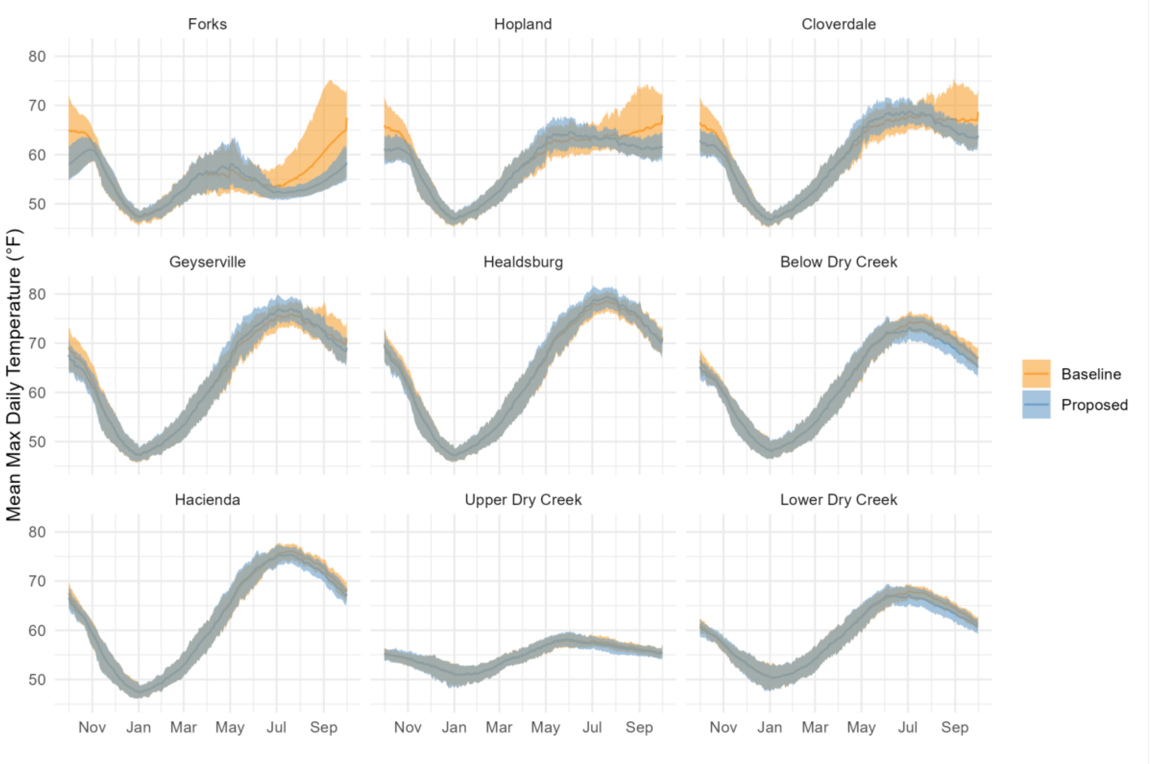
   a. Since the model results are summarized as daily maxima the lethal threshold was selected as a means evaluating impacts of the Proposed Action.



SOURCE: Sonoma Water (2016)

Figure 6-18
Water Quality Modeling Locations

Average daily maximum temperatures are shown below in **Figure 6-19** for a series of locations for the Upper and Lower Russian River and Dry Creek.



Note: Ribbons show 10% and 90% quantiles.

Figure 6-19
Average Daily Maximum Temperature by Location/Model Node

Upper Russian River

Water temperature within the upper Russian River is represented by the model nodes at Forks, Hopland, Coverdale, Geyserville, and Healdsburg. At the three most upstream stations (Forks, Hopland, and Cloverdale) water temperatures are generally warmer between August and October under the baseline relative to the Proposed Action. Conversely, from May through July water temperatures are generally warmer under the Proposed Action relative to the baseline. Although less pronounced, the same pattern is present at the Geyserville and Healdsburg nodes.

Lower Russian River

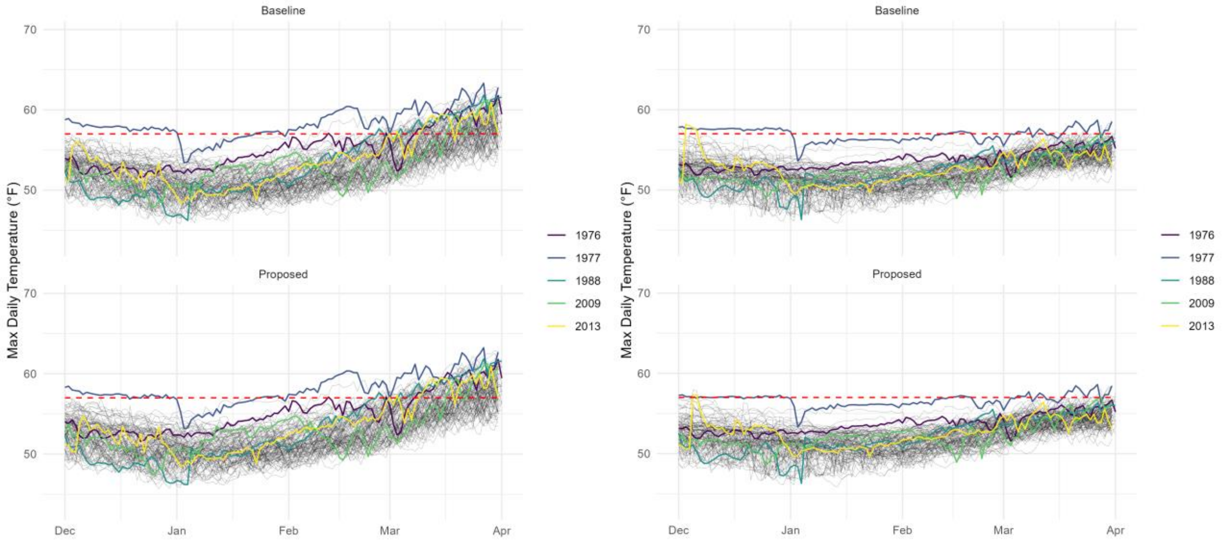
Water temperature in the lower Russian River is represented by the model nodes Below Dry Creek and Hacienda. At both these nodes water temperatures are similar between the Proposed Action and baseline, with slight deviations between May and October at both nodes. At the node Below Dry Creek. At the node downstream of Dry Creek, temperatures are slightly higher under the proposed Action relative to the baseline between May and July, and slightly higher under the baseline relative to the Proposed Action between July and October. At the Hacienda node, water temperatures are slightly elevated between May and September under the Proposed Action relative to the baseline.

Dry Creek

Water temperature within Dry Creek is represented by the upper Dry Creek and lower Dry Creek nodes. Water temperatures at both nodes are very similar under the Proposed Action and baseline for much of the year. There are slight elevations under the Proposed Action during June and July, with reductions of a similar magnitude under the Proposed Action from approximately August to October.

Species Effects

To analyze how changes in water temperature between the baseline and Proposed Action could affect Coho Salmon, Chinook Salmon and steelhead exceedance of lethal temperature thresholds were analyzed daily over the full period of record. To generate the proportion of days exceeding lethal thresholds, max daily temperatures from the full period of record were compared against the lethal thresholds for each species and life-stage (see Tables 6-26 through 6-28). **Figure 6-20** below illustrates the max daily temperature for the full period of record compared against the lethal threshold for Coho Salmon spawning and egg incubation (57.1° F) at the two nodes within Dry Creek.[492] Water years 1976 (Schedule 4), 1977 (Schedule 5), 1988 (Schedule 3 - Dry Spring), 2009 (Schedule 3 - Dry Fall), and 2013 (Dry Spring) are highlighted to show how different water year types are distributed across the full period of record (See Section 3.3.2.1, *Water Supply Releases and Minimum Instream Flows*).



Lower Dry Creek **Upper Dry Creek**

Note: Coho Salmon Egg Spawning and Egg Incubation

Figure 6-20
Maximum Daily Temperature by Location/Model Node

The proportion of days (or observations) exceeding lethal thresholds are shown below in **Figure 6-21** through **6-25** by location/node and species/lifestage. Importantly, 75° F is used as the lethal

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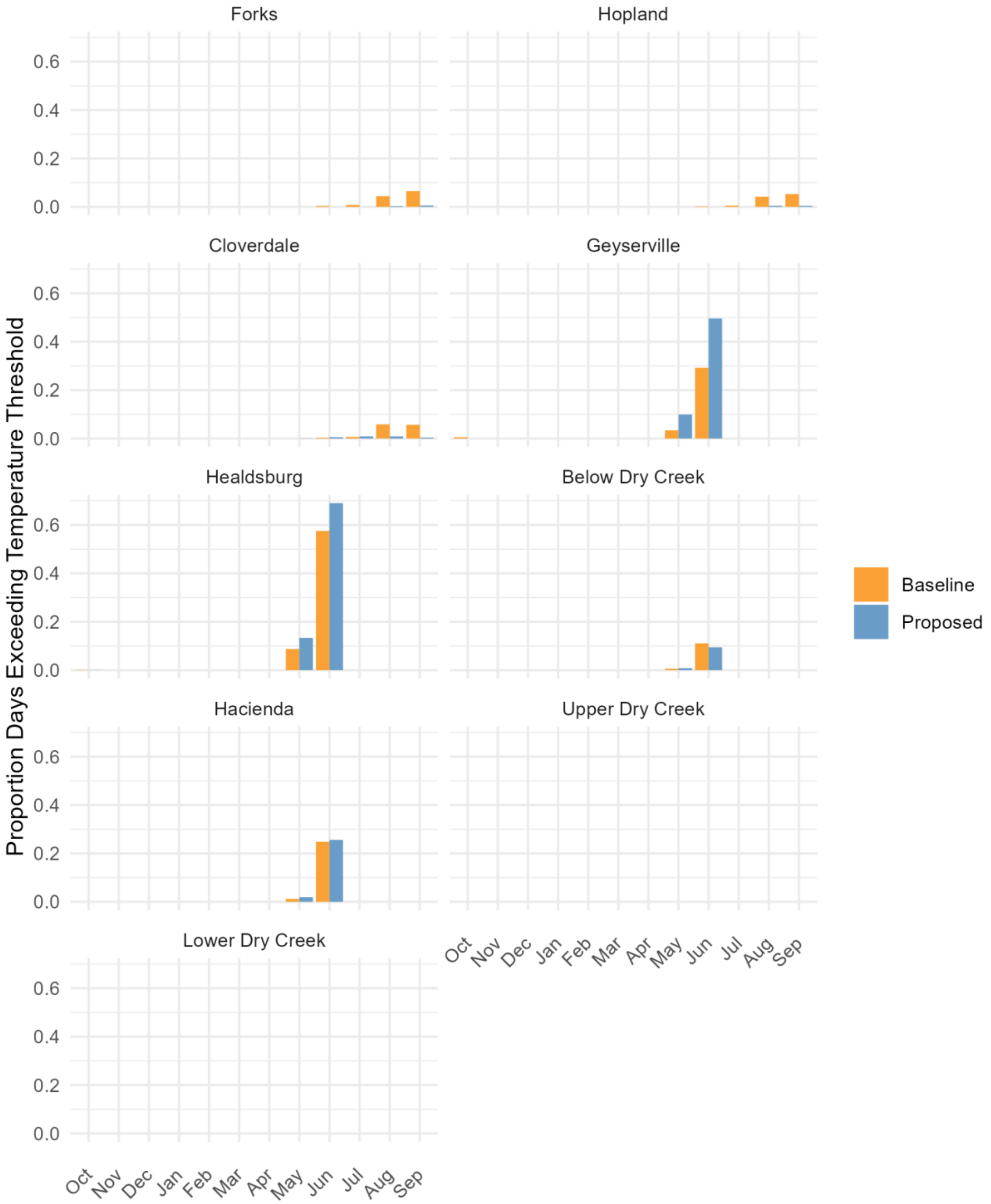
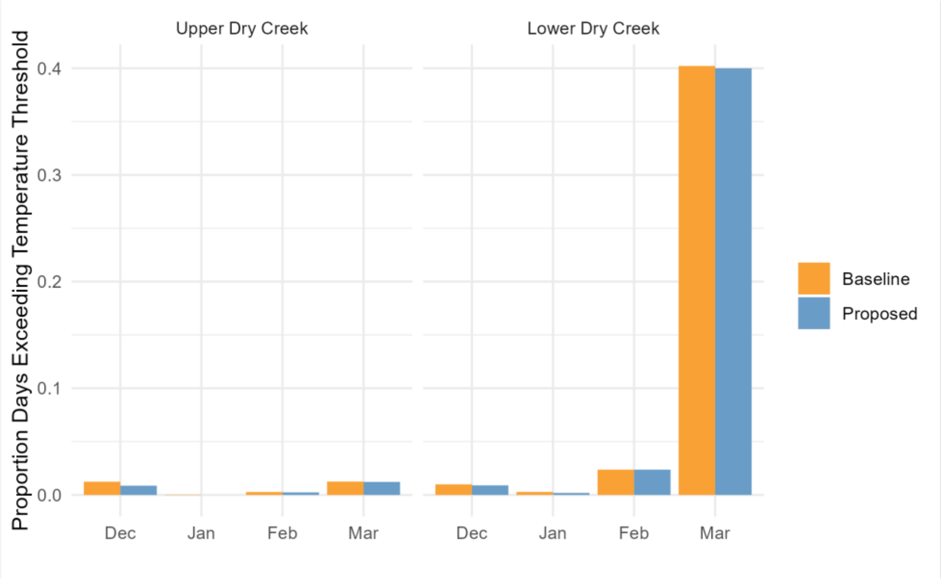
[492] See Appendix A, Temperature Modeling for figures of all additional figures for Coho Salmon, Chinook Salmon, and steelhead by lifestage.

limit for all Coho Salmon, Chinook Salmon, and steelhead for all life-stages except spawning and egg incubation. A spawning and egg incubation lethal threshold of 64° F is used for Chinook Salmon and steelhead, and threshold of 57.1° F is used for Coho Salmon.



Note: Adult and Juvenile Coho Salmon, Chinook Salmon, and steelhead

Figure 6-21
Proportion of Days Exceeding Lethal Temperature Threshold (75° F)



Note: Coho Salmon spawning and egg incubation

Figure 6-22
Proportion of Days Exceeding Lethal Temperature Threshold (57.1° F)

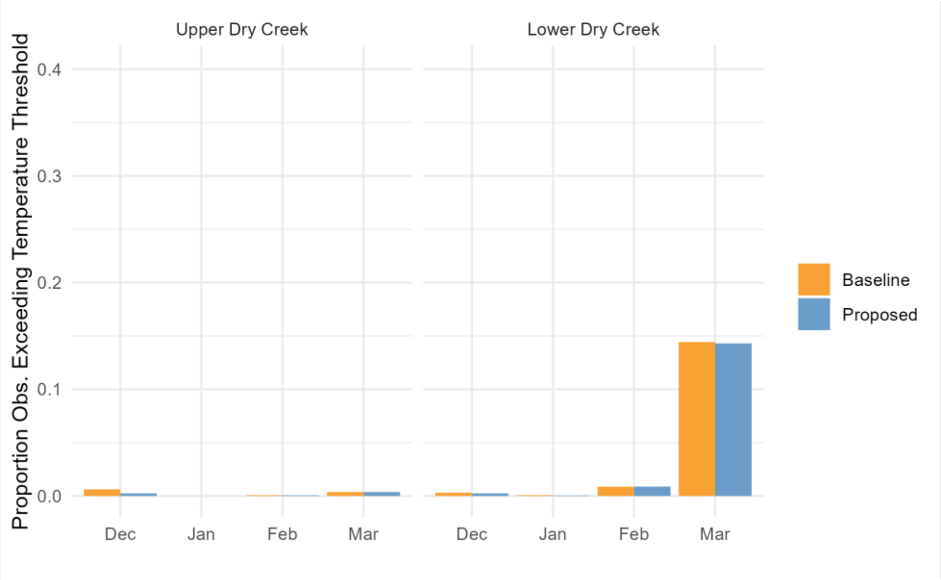
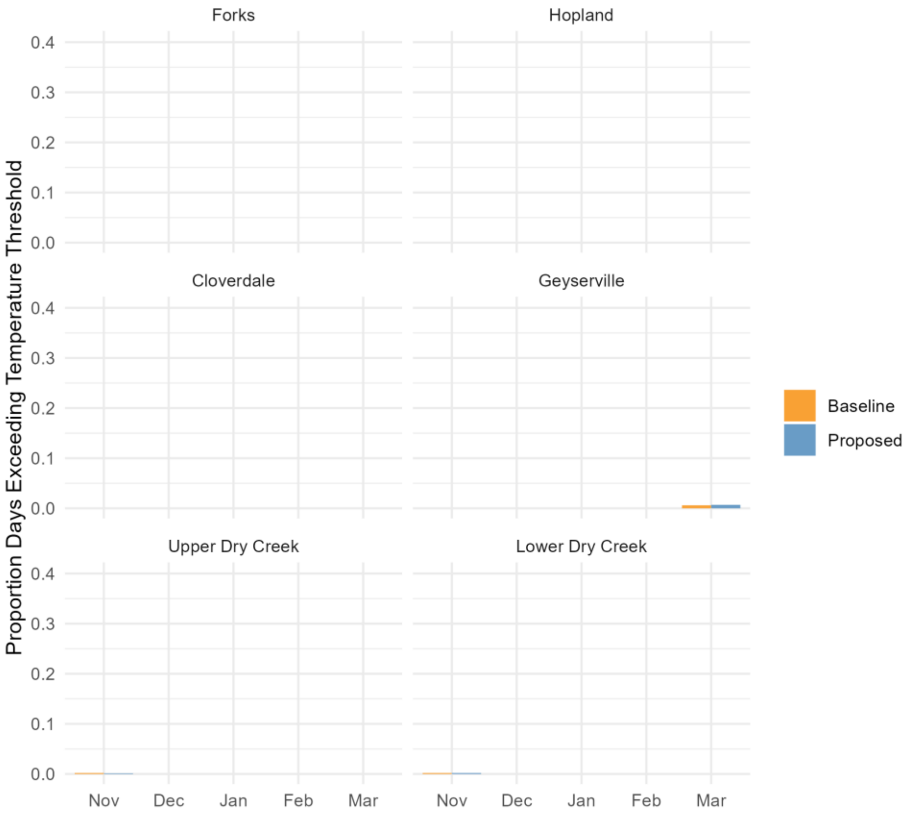


Figure 6-23
Proportion of Observations Exceeding Lethal Temperature Threshold (57.1° F)



Note: Chinook Salmon spawning and egg incubation

Figure 6-24
Proportion of Days Exceeding Lethal Temperature Threshold (64° F)

Note: Steelhead spawning and egg incubation

Figure 6-25
Proportion of Days Exceeding Lethal Temperature Threshold (64° F)

Chinook Salmon

Chinook Salmon migrate upstream to their spawning grounds from October through December (primarily mid-October through mid-November). Spawning begins in mid-November and likely extends into January in normal years. The subsequent egg incubation period extends through March. Juvenile Chinook Salmon rear in the Russian River and Dry Creek from March through June. Chinook Salmon in the Russian River smolt during the first few months of their lives, and downstream migrating Chinook Salmon are routinely captured in the downstream migrant trap operated at the Mirabel Inflatable Dam during this time (March through June).

Adult Migration

During the adult Chinook Salmon migration period, maximum daily water temperatures in the upper Russian River were modeled to be lower during October and early November compared to baseline conditions. From mid-November through December maximum daily temperatures were very similar between the two scenarios, with no exceedance of the lethal threshold during this period. Similarly, water temperatures in Dry Creek varied very little between the baseline and Proposed Action from October through December.

Both the baseline and the Proposed Action support suitable water temperature conditions in the upper Russian River and Dry Creek during the Chinook Salmon upstream migration period. The Proposed Action would provide a reduction in the frequency of occurrence of stressful (sub-lethal) water temperatures during October (prior to the peak of the run). From November and December, stressful water temperatures would rarely occur for the baseline or Proposed Action. The Proposed Action would not negatively affect the upstream migration for Chinook Salmon through elevated water temperatures from October through December in the Russian River or in Dry Creek and therefore, no adverse effects are expected to result.

Spawning and Egg Incubation

Under the Proposed Action, modeled maximum daily water temperatures from November 15 through March range are slightly higher in the upper Russian River, but do not approach the lethal limit under either scenario.[493] Modeled stressful water temperatures occur slightly more often at the Forks under the Proposed Action compared to baseline conditions during the second half of November; but would be similar for all other locations in the upper Russian River. In Dry Creek, maximum daily temperatures, and the frequency of occurrence of stressful water temperatures would be essentially the same under the baseline and Proposed Action. The Proposed Action would not substantially adversely affect the quality of water by elevated water temperatures from November 15 through March to Chinook Salmon spawning and egg incubation.

Juvenile Rearing

In the Russian River above Geyserville, modeled daily maximum water temperatures from April through June were generally higher under the Proposed Action compared to baseline conditions. Modeled daily water temperatures increased to stressful and lethal levels between Geyserville and Healdsburg for the Proposed Action and under baseline conditions, particularly in June. The frequency of occurrence of stressful conditions and proportion of days with maximum temperatures exceeding the lethal threshold is higher at Geyserville and Healdsburg for the Proposed Action from May through June. As stated above, during April through June, rearing juvenile Chinook Salmon are in the process of migrating to the lower Russian River where Dry Creek moderates the temperatures. Based on the results from Sonoma Water's annual downstream migrant trapping in the Russian River, most juvenile Chinook Salmon have migrated downstream of Healdsburg by the end of May. Therefore, the small increase in water temperatures would not substantially affect the habitat quality for rearing Chinook juveniles from April through June and is considered a negligible effect.

Smolt Emigration

Juvenile Chinook Salmon rear in freshwater for 2 to 4 months before entering the ocean. The rearing and smoltification phases are intertwined, and "rearing" juveniles slowly morph into

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[493] SCWA, 2016, *Op. cit.*

"smolts." Under the assumption that smolts are more inclined to migrate downstream, the lower Russian River is emphasized when assessing potential impacts to smolts. This assumption is supported by migrant trapping in the upper Russian River near Healdsburg, where numbers of juvenile Chinook Salmon rapidly declined after May 31.[494] Secondly, the upper Russian River becomes inhospitable to smolts in June under baseline conditions. An additional factor to consider is the effect of Dry Creek on the presence of juvenile/smolt Chinook Salmon in the lower Russian River during June and July. Coldwater releases from WSD maintain artificially cold (and stable) temperatures in Dry Creek. This likely results in some Chinook juveniles delaying the onset of emigration. Chinook Salmon smolts were captured in a downstream migrant trap in Dry Creek in June, with very low numbers.

Modeled daily maximum water temperatures in the lower Russian River suggest slight increases under the Proposed Action relative to baseline conditions as seen at the node Below Dry Creek and at Hacienda. For the Proposed Action, suitable water temperatures for emigrating Chinook Salmon smolts during April would be present throughout the action area. Overall, lethal threshold exceedance in the lower Russian River modeled to occur on approximately 2 percent of days in May under the baseline and 3 percent under the Proposed Action. In June, that exceedance jumped to 25 and 28 percent of days, with slight variability, under the baseline and the Proposed Action, respectively. The timing of these slight differences in temperature would not substantially affect the emigrating Chinook Salmon smolts from April through July 15 in the Russian River and in Dry Creek and therefore, any temperature effects on Chinook Salmon would be negligible.

Coho Salmon

Coho Salmon inhabit selected streams from the Maacama Creek (near Healdsburg) downstream to Willow Creek near the Russian River Estuary. Coho Salmon do not spawn or rear in the mainstem Russian River. Adults migrate upstream from December through February, and spawning takes place shortly after the adults migrate. Juveniles rear in their natal streams for approximately one year before emigrating as smolts from March through May, with peak emigration occurring during the first two weeks of May.

Adult Migration

Modeled daily maximum water temperatures in the lower Russian River and in Dry Creek are almost identical under the Proposed Action and baseline conditions during the November through February Coho Salmon upstream migration period; well below the lethal limit under both scenarios.[495] Sub-lethal effects on migrating adults are also unlikely, as modeled daily maximum water temperatures also remain below 59°F in Dry Creek throughout the Coho Salmon upstream migration period. In the lower Russian River, modeled water temperatures remain below 59°F during November and January, and rarely exceed 59°F during February under the Proposed Action. Lethal or stressful conditions would not occur under the Proposed Action during the Coho Salmon upstream migration period. The Proposed Action would not affect the Coho Salmon upstream migration through elevated water temperatures during the months November

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[494] J. Martini-Lamb and Manning, D.J. editors. 2020. *Op. cit.*

[495] SCWA, 2016, *Op. cit.*

through February. Therefore, there are no adverse effects on upstream migrating Coho Salmon under the Proposed Action.

Spawning and Egg Incubation

Modeled daily maximum water temperatures in Dry Creek during the Coho Salmon spawning and egg incubation period would be very similar to baseline conditions. Lethal water temperatures (>57.1° F) rarely occur during January and February (on less than 5% of days) but occur on just under 40 percent of days during March for the Proposed Action and baseline conditions. When viewed at a refined time-step (6-hour increment), the proportion of time in March that the lethal threshold is exceeded drops to approximately 14 percent under both the baseline and Proposed Action (Figure 6-23). The 6-hour time-step provides greater resolution into diurnal variations in water temperature and illustrates that exceedance of the 57.1° F likely occurs for only portions of a 24-hour day. Additionally, Coho Salmon are typically done spawning prior to March and are not known to spawn in the lower reaches of Dry Creek. Furthermore, water temperatures in the spawning gravels that support egg incubation are likely cooler than the surrounding water column, which is represented by the model simulations.

Overall, the change in the occurrence of lethal water temperatures between baseline conditions and the Proposed Action are expected to be negligible. As there would be no increase in elevated water temperatures during the months December through March in Dry Creek the Proposed Action would not result in adverse effects on the spawning and egg incubation of Coho Salmon.

Juvenile Rearing

Modeled daily maximum water temperatures in lower Dry Creek would be slightly warmer in June and slightly cooler in August for the Proposed Action compared to baseline conditions. The same pattern is present within upper Dry Creek, albeit at a lesser magnitude. Lethal or stressful water temperatures (>64.0°F) would not occur in upper Dry Creek during the juvenile Coho Salmon rearing period. In lower Dry Creek, the Proposed Action would increase the occurrence of stressful water temperatures slightly in June and decrease their occurrence slightly in August. Lethal temperatures do not occur in Dry Creek under baseline conditions or the Proposed Action. The Proposed Action would not affect the quality of habitat for rearing Coho Salmon juveniles by elevated water temperatures from April through November in Dry Creek, therefore no impacts would occur.

Smolt Emigration

Only slight differences (<0.5°F) in modeled daily maximum water temperatures in the lower Russian River would occur between March and May under the Proposed Action and baseline conditions. In Dry Creek, maximum daily water temperatures are also consistent between the two scenarios from March to May. The difference in the frequency of occurrence of stressful water temperatures was less than 5 percent per month at all sites, and in the lower Russian River (Hacienda) was less than 3 percent over all months.

Additional analysis was conducted in the Russian River between Healdsburg and the confluence with Dry Creek in response to the increased water temperatures modeled under the Proposed Action. Coho Salmon emigration generally peaks during the first two weeks of May, then quickly declines thereafter. After mid-May, maximum daily water temperatures modeled to increase at a higher rate under the Proposed Action.[496] However, the increase in potentially lethal conditions affects a small portion of the Coho Salmon smolts (fish leaving the Maacama system); occurs late in the season after the majority of smolts have emigrated to the lower Russian River; and affects a very short stretch of river (Maacama downstream to Dry Creek). While these elevated water temperatures potentially could affect late emigrating Coho smolts from the Maacama system, overall effects on emigrating Coho smolts are expected to be negligible.

Steelhead

Steelhead are the most widely distributed salmonid in the Russian River watershed. Adults migrate upstream primarily from December through March and spawn in the mainstem Russian as well as a multitude of tributaries, including Dry Creek. Although no steelhead spawning surveys have been conducted in the mainstem Russian River, spawning habitat is assumed to coincide with available juvenile rearing habitat (upstream of Cloverdale). Spawning begins shortly after the adult migration begins, and likely continues through March, with egg incubation lasting through April for late spawning fish. Juvenile rearing habitat in the mainstem is limited by water temperature to the river above Cloverdale. Smolts emigrate from approximately December through May.

Adult Migration

Modeled daily maximum water temperatures in the upper Russian River would be slightly warmer in December and nearly identical during the remainder of the steelhead upstream migration period under the Proposed Action compared to baseline conditions. Based on model results, lethal water temperatures would not occur during the steelhead migration season, and stressful water temperatures would not occur during December through February, and rarely during March. Water temperatures in Dry Creek would be similar to baseline conditions throughout the steelhead upstream migration period. There would be no adverse effects on migrating adult steelhead from the Proposed Action.

Spawning and Egg Incubation

Modeled daily maximum water temperatures in the Russian River upstream of Cloverdale, would be slightly higher from December through April compared to baseline conditions. Lethal water temperatures would not occur during the peak spawning months from December through March. During April, modeled water temperature suitability deteriorated for baseline conditions and the Proposed Action. Overall, lethal water temperatures would occur more often, particularly at Cloverdale, as a result of the Proposed Action. Importantly, only a small portion of the overall steelhead population spawns in the mainstem upstream of Cloverdale.[497]

Modeled daily maximum water temperatures in upper Dry Creek would be sublethal from December through April, and in lower Dry Creek from December through March. Modeled daily maximum water temperatures occur at approximately the same rate under the Proposed Action

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[496] SCWA, 2016, *Op. cit.*

[497] SCWA, 2016, *Op. cit.*

and baseline, and occur primarily during the last two weeks of April at the end of the steelhead egg incubation period, and thus would only affect a small proportion of the spawning population.

In addition, the analysis of applying results from modeled surface waters to assess the potential effects of elevated water temperatures to developing eggs presents limitations. For example, the model does not take into account for the intra-gravel water temperatures which tend to be cooler than surface temperatures.[498] Thus, the Proposed Action would not adversely affect the spawning and egg incubation of steelhead through elevated water temperatures in the months December through April in the Russian River and in Dry Creek.

Juvenile Rearing

Modeled daily maximum water temperatures in the Russian River between the Forks and Cloverdale would higher from April through June, and cooler August through October, under the Proposed Action compared to baseline conditions. The occurrence of lethal water temperatures would be extremely rare under both scenarios from Cloverdale upstream between April and September. In Dry Creek, modeled water temperatures would be near optimal throughout the juvenile steelhead rearing period. The primary difference between baseline conditions and the Proposed Action is that daily maximum water temperatures would be delayed approximately one month and would be cooler under the Proposed Action. This would result in an improvement in habitat conditions for rearing juvenile steelhead in the Russian River and Dry Creek and therefore the Proposed Action would provide a habitat benefit upstream of Cloverdale in the months April through November.

Smolt Emigration

As described above, modeled daily maximum water temperatures in the Russian River upstream of Cloverdale, would be slightly warmer under the Proposed Action relative baseline conditions from December through April. Modeled daily maximum mean water temperatures in the upper Russian River would increase in May compared to baseline conditions. However, downstream of the confluence of Dry Creek, daily maximum water temperatures vary little between baseline conditions and the Proposed Action. Modeled lethal water temperatures at Hacienda occur on less than 5% of days under both baseline conditions and the Proposed Action. Although the Proposed Action would increase the occurrence of lethal water temperatures in portions the upper Russian River in May (primarily at Geyserville and Healdsburg), the occurrence of lethal water temperatures was essentially unchanged in the lower Russian River. In upper Dry Creek, maximum daily water temperatures are near optimal for emigrating steelhead smolts; however, in the lower reach of Dry Creek, temperatures deteriorate from suitable in March to May under baseline conditions and the Proposed Action; but remain well below the lethal limit. The Proposed Action would not affect the emigrating steelhead smolts through elevated water temperatures in the months March through May in the Russian River and in Dry Creek.

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[498] Magneson, M.D. 2016. Klamath and Trinity River intra-gravel water temperatures, 2014 and 2015. U.S. Fish and Wildlife Service, Arcata, California.

TUCO Water Quality Monitoring

Monitoring conducted as part of the TUCOs suggest that water quality conditions are generally favorable for salmonids in the Russian River for life stages that are expected to occur during the typical Order periods. Monitoring during the 2020 TUCO (June 1 to December 27) found that instream conditions did not impede adult salmonid upstream passage at Mirabel. When Chinook first began migrating upstream in 2020, water temperature at Hacienda was stressful to acutely stressful, but quickly changed to suitable to optimal.[499] Water temperatures at sites upstream of Hacienda followed a similar trend where temperatures were acutely stressful to stressful then decreased as air temperatures decreased with the onset of fall. By November water temperatures were suitable to optimal for adult Chinook at all sites. By mid-November water temperatures were suitable or optimal for adult Coho and adult steelhead at all sites. While temperatures were occasionally unfavorable for adult salmonids it is important to note that (1) these fish have evolved to cope with seasonally warm water temperatures by returning to the river in the fall when water temperatures are beginning to cool and (2) the vast majority of adult salmonids return to the Russian River after water temperatures in the river have become favorable.[500]

For juvenile Chinook, water temperatures were favorable for rearing in the early spring at most sites but became unfavorable by the end of the rearing season. Water temperatures remained stressful to optimal at Hopland. Fish that remained in the river and emigrated as smolts late in the rearing season encountered unfavorable water temperatures as they moved downstream and out to sea. It is important to note that Chinook have likely adapted to warm temperatures in the Russian River and may have adjusted their run timing to further cope with seasonally warmer water temperatures by emigrating earlier in the year.[501]

Water temperatures near Hopland were favorable for steelhead rearing throughout the Order. In the Russian River near the confluence with Pieta Creek and near Hopland water temperature was typically stressful to optimal for rearing steelhead. However, water temperatures fell to optimal levels by November due to cooling air temperatures.

Chinook Salmon had favorable water temperatures for smoltification at Hopland. Water temperatures became acutely stressful and even lethal after June 1 at the downstream monitoring sites. However, the bulk of Chinook smolts emigrate from the Russian River prior to June 1 when water temperatures are more favorable. Some Chinook smolts are captured after June 1 in a downstream migrant trap operated by Sonoma Water on Dry Creek, after water temperatures in the Russian River became stressful and acutely stressful at Hacienda. Cold water released from Lake Sonoma may keep Chinook smolts from receiving migration cues they might otherwise receive as the water warmed from changing seasons. This may delay Chinook smolt emigration from Dry Creek. Once late emigrating fish leave Dry Creek, they would experience stressful and acutely stressful temperatures in the lower Russian River.

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[499] Sonoma Water defines the upper temperature thresholds for Chinook as acutely stressful if water temperatures exceed 67°C, stressful as exceeding 64°C, suitable as 60°C, and optimal as anything less than 60°C.

[500] Sonoma Water, 2021. *Op. cit.*

[501] Crozier, L.G., Burke, B.J., Chasco, B.E. et al. 2021. Climate change threatens Chinook salmon throughout their life cycle. Commun Biol 4, 222. https://doi.org/10.1038/s42003-021-01734-w

Dissolved oxygen was generally favorable for salmonids at all monitoring sites and for the duration of the Order.[502] The 7-day running average of the minimum dissolved oxygen occasionally became stressful for salmonids at Hopland and in the Russian River near the confluence with Pieta Creek. At Jimtown, Digger Bend, and Hacienda the 7-day running average of the minimum dissolved oxygen was frequently stressful for salmonids, but the least favorable conditions occurred mainly during the summer months when salmonids would not be occupying this section of the river.[503]

6.2.4.2 Dissolved Oxygen

Temperature influences an organism's metabolism which in turn influences the dissolved oxygen (DO) demand placed on that organism. As water warms, salmonids requirements for DO also increases. Dissolved oxygen levels ≥8.0 are required for Chinook Salmon.[504] A review summarized several studies and concluded that food conversion was impaired at DO concentrations less than 5.0 mg/l and that salmonids were not impaired when DO concentrations exceeded 8 mg/l.[505] Coho Salmon avoid waters with DO concentrations less than 4.5 mg/l Chinook Salmon reportedly avoid DO concentrations below 5.0 mg/l.[506] For all three salmonids in the Russian River, the lower lethal limit for DO is around 1.0 – 3.0 mg/l depending on temperature.[507]

Dissolved oxygen in excess of 6.3 mg/l are recommended for upstream migrating salmonids.[508] Survival and emergence of fry was high at DO levels in excesses of 8.0 mg/l. Conversely, embryo survival was significantly reduced at DO levels below 6.5 mg/l.[509] Adult Chinook Salmon avoided DO levels below 4.2 mg/l. Migration resumed when DO increased above 5.0 mg/l.[510]

Defining DO criteria for fish is complicated by the interaction between temperature and DO. Colder water has a higher saturation level (holds more oxygen). Although some sources reviewed suggest that optimal DO levels for salmonids is 12 ppm, this level may not be appropriate for the Russian River.[511] In general, the "amount" of oxygen that can be dissolved into water is controlled by temperature (water can become "supersaturated" under turbulent conditions or at

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[502] Sonoma Water defines Salmonid DO thresholds as follows: lethal <3, acutely stressful 3.0-4.9, stressful 5.0-7.9, suitable 8.0-11.9, and optimal >12 mg/l.

[503] Sonoma Water, 2021. *Op. cit.*

[504] Bratovich, P, D Olson, A Pitts, M Atherstone, A Niggemyer, A O'Connell, K Riggs, and B Elliot. 2004. "Matrix of life history and habitat requirements for Feather River fish species: Chinook salmon." Oroville Facilities Relicensing: FERC Project No. 2100.

[505] Bjornn, T C, and R W Reiser. 1991. Habitat requirements of salmonids in streams. Vol. Special Publication 19, in Influences of forest and rangeland management on salmonid fishes and their habtiats, edited by W. R. Meehan, 83-138. Bethesda, Maryland: American Fisheries Society.

[506] Hallock, R J, R F Elwell, and D H Fry. 1970. "Migration of adult king salmon Oncorhynchus tshawytscha in the San Joaquin Delta as demonstrated by the use of sonic tags." Department of Fish Game Fish Bulletin 151.

[507] Doudoroff, P., and D L Shumway. 1970. FAO Fisheries Technical Paper 86: Dissolved oxygen requirements of freshwater fishes. 291 p.

[508] Davis, John. 1975. Minimal Dissolved Oxygen Requirements of Aquatic Life with Emphasis on Canadian Species: A Review. Department of the Environment, Fisheries and Marine Service. J. Fish. Res. Bd.

[509] McMahon, T E. 1983. "Habitat suitability index models: coho salmon." FWS/OBS-82/10.49., Department of the Interior, Fish and Wildlife Service, 29.

[510] Hallock, R J, R F Elwell, and D H Fry. 1970. *Op. cit.*

[511] Raleigh, R.F., T.Hickman, R.C. Solomon, and P.C. Nelson. 1984. "Habitat suitability information: rainbow trout." FWS/OBS-82/10.60, U.S. Fish and Wildlife Service.

high levels of plant respiration). Water at 100% oxygen saturated reaches 12 ppm at a temperature of 44.5° F. Since water in the Russian River rarely, if ever, cools to that level, achieving a 12.0 ppm DO level in the Russian River may not be possible. While this may be the case, higher (than 8.0 ppm) DO levels are beneficial to salmonids.

Modeled monthly mean DO levels were modeled for the upper and lower Russian River and Dry Creek. These results are shown below in Tables **6-31** through **6-33.**

TABLE 6-31
MEAN MONTHLY DO UPPER RUSSIAN RIVER

Scenario	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Forks												
Baseline	6.1	9.2	10.8	11.0	10.6	10	9.2	8.3	7.0	5.4	4.2	4.3
Proposed Action	4.3	8.2	10.6	10.9	10.6	10	9.3	8.3	7.0	5.8	4.6	4.0
Hopland												
Baseline	9.5	10.4	11.4	11.5	11.1	10.7	10.4	10.3	10.1	9.9	9.8	9.7
Proposed Action	9.9	10.4	11.3	11.4	11.1	10.7	10.4	10.1	10.1	10	10.2	10.2
Cloverdale												
Baseline	9.6	10.4	11.3	11.3	10.9	10.5	10.2	10.1	9.9	9.5	9.6	9.6
Proposed Action	9.9	10.4	11.2	11.3	10.9	10.5	10.2	9.9	9.7	9.5	9.8	10.1
Geyserville												
Baseline	9.4	10.3	11.3	11.5	11.1	10.6	10.2	9.9	9.3	8.6	8.9	9.3
Proposed Action	9.6	10.4	11.3	11.4	11.1	10.6	10.2	9.8	9.1	8.5	8.9	9.5
Healdsburg												
Baseline	9.2	10.3	11.4	11.5	11.1	10.5	9.9	9.4	8.9	8.4	8.4	8.8
Proposed Action	9.3	10.4	11.4	11.5	11.1	10.5	9.9	9.4	8.8	8.3	8.3	8.8

SOURCE: Sonoma Water, 2023.

TABLE 6-32
MEAN MONTHLY DO LOWER RUSSIAN RIVER

Scenario	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Hacienda												
Baseline	9.4	10.4	11.2	11.4	11	10.4	9.8	9.4	9.5	9.2	8.9	8.9
Proposed Action	9.5	10.4	11.2	11.3	11	10.4	9.8	9.4	9.5	9.3	9.0	9.0

SOURCE: Sonoma Water, 2023.

TABLE 6-33
MEAN MONTHLY DO DRY CREEK

Scenario	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Upper Dry Creek												
Baseline	9.8	9.9	10.3	10.7	10.8	10.6	10.4	10.4	10.2	10.1	10.0	9.9
Proposed Action	9.8	9.9	10.3	10.7	10.8	10.6	10.4	10.3	10.2	10.1	10.0	9.9
Lower Dry Creek												
Baseline	10.3	10.4	10.7	11.0	10.9	10.6	10.4	10.2	10	9.9	10.0	10.3
Proposed Action	10.3	10.4	10.7	11.0	10.9	10.6	10.4	10.2	10.1	10.0	10.1	10.3

SOURCE: Sonoma Water, 2023.

Upper Russian River

During the late fall, winter, and early spring, water stored in Lake Mendocino remains well mixed, and water released from the reservoir is well oxygenated. In addition, atmospheric conditions and tributary input help to maintain DO levels at or near saturation. However, beginning in May of most years, DO levels in the water released below the reservoir begins to decrease. This continues through the summer and early fall until the lake “turns over” and the process starts anew. The general pattern follows the development and depletion of the cold-water pool in Lake Mendocino. Minimum DO levels are present at the outlet of the reservoir, but increase with distance downstream, as water entrains oxygen as it tumbles over downstream riffles. In general, modeled DO levels are higher under the Proposed Action during July and August, and lower during October compared to baseline conditions.[512] The potential for low DO levels released from Lake Mendocino occurs during the summer through early fall, thus, its potential to influence fish populations is limited to species present during this timeframe.

Lower Russian River

Dissolved oxygen levels in the lower Russian River are minimally influenced by releases from the WSD and CVD. Releases from WSD typically have adequate DO levels, and water released from CVD has flowed approximately 113 km and has had adequate time to become fully re-oxygenated. In general, DO levels were modeled to be suitable for all species of fish in the river (8.0 ppm or higher) under the Proposed Action. Modeled DO levels were similar under baseline conditions and the Proposed Action; thus, there are no project related impacts associated with DO levels in the lower Russian River.

Dry Creek

Lake Sonoma, with its large cold-water pool, maintained cold-water releases under the driest conditions modeled (1977 water year). Water released from Lake Sonoma flows over a large weir (cascade) immediately after release from the reservoir, and the relatively high gradient of Dry Creek (compared to the Russian River) results in a high energy system where water is rapidly, and repeatedly, mixed with air. As a result, modeled DO levels in Dry Creek under the baseline

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[512] SCWA, 2016, *Op. cit.*

and Proposed Action remained above 8 ppm (suitable to near optimal levels) throughout the year as well as during the driest conditions modeled. There are no DO related impacts from the Proposed Action in Dry Creek.

Species Effects

Based on the water quality model, potential impacts related to low DO levels are limited to the first few km of the Russian River downstream of CVD. Because low DO levels are limited spatially and temporally, the species potentially impacted by low DO are upstream migrating Chinook Salmon and rearing juvenile steelhead. **Table 6-34** presents the rationale for the inclusion or exclusion of species and life stages from the analysis.

TABLE 6-34
POTENTIAL FOR EACH SPECIES AND LIFE STAGE TO BE NEGATIVELY IMPACTED BY LOW DO LEVELS IN THE RUSSIAN RIVER AND DRY CREEK

Species	Life Stage	Susceptibility to low DO	Rationale
Chinook	Upstream migration	Potential Effect	Early (October) arriving adults may encounter stressful DO levels in the upper Russian River. Potential effects are discussed below.
	Spawning and Incubation	None	Modeled DO levels are suitable under all flow scenarios throughout the Chinook Salmon spawning and incubation period.
	Rearing	None	Modeled DO levels are suitable under all flow scenarios in areas occupied by rearing juvenile Chinook Salmon throughout the rearing season.
	Smolt	None	Chinook Salmon smolts have emigrated to the ocean prior to the onset of low DO levels in the upper Russian River.
Coho	Upstream migration	None	Coho Salmon do no occupy areas modeled to experience stressful DO levels.
	Spawning and Incubation		
	Rearing		
	Smolt		
Steelhead	Upstream migration	None	Modeled DO levels are suitable throughout the upstream migration period.
	Spawning and Incubation	None	Modeled DO levels are suitable throughout the spawning and incubation period.
	Rearing	Potential Effect	Juvenile steelhead rear in the upper Russian River when DO levels were modeled to be stressful. Potential effects are discussed below.
	Smolt	None	Smolts have immigrated to the ocean prior to the onset of stressful DO levels in the upper Russian River.

SOURCE: SCWA, 2016. Fish Habitat Flows and Water Rights Project – Draft Environmental Impact Report. July 2016.

Chinook Upstream Migration

The modeled mean DO levels during October in the water released from Lake Mendocino would be 4.3 ppm for the Proposed Action and 6.1 ppm for baseline conditions at the Forks Gage. The reductions in DO levels begin at CVD and extends to approximately 3 km downstream. After that point, the modeled mean DO levels increase to approximately 9.5 ppm under baseline conditions and approximately 9.9 ppm for the Proposed Action at the Hopland Gage. Below this point, DO levels are suitable for upstream migrating Chinook Salmon for baseline conditions and the Proposed Action.[513] Although the reduced DO levels could affect upstream migrating Chinook Salmon, the occurrence would be short-term and occur prior to when most fish would have accessed the upper Russian River. This area occupies only 2 percent of the Russian River and most Chinook Salmon spawning occurs downstream of this area. Few Chinook adults would have the potential to be affected by the low DO levels that could occur below CVD. By November, model results show that DO levels increase for both baseline conditions and the Proposed Action and would provide adequate conditions for upstream migrating Chinook Salmon throughout the river. For the Proposed Action, dissolved oxygen levels in Dry Creek would remain above levels (>8.0 ppm) suitable for upstream migrating Chinook Salmon throughout the migration period. Since Dry Creek DO levels would be suitable for the entire migration period and the reduced DO levels in the upper Russian River would only occur for a short period and when most fish would not have accessed the three-km section area, the Proposed Action would have negligible effect on the upstream migration of Chinook Salmon in the months October through December in the Russian River and in Dry Creek.

Steelhead Juvenile Rearing

The modeled monthly mean DO levels in the water released from CVD under the Proposed Action would be similar to baseline conditions during April through June with an increase during July and August. DO levels would begin to decline in October, but recover slightly during November compared to baseline conditions. Modeled DO levels 6 km downstream of CVD at Cloverdale would be above 8.0 ppm for the Proposed Action and baseline conditions and stressful levels would not occur within this reach of the river. However, in the upper 3+ km, DO levels would range from stressful to potentially lethal levels from August through October for the Proposed Action and baseline conditions. The Proposed Action would have the same minimum monthly mean DO level as baseline conditions, but the minimums would occur one month apart for the Proposed Action. The reduced DO levels in this timeframe would occur in the three-km section of the upper Russian River for the Proposed Action and baseline conditions. In Dry Creek, DO is favorable for steelhead under baseline conditions and under the Proposed Action. Thus, the Proposed Action would not affect the habitat for rearing juvenile steelhead through reduced DO levels in the months April through November in the Russian River and in Dry Creek.

6.2.4.3 Turbidity

Increased turbidity in the Russian River is associated with water supply releases (i.e., generally between April 1 and October 31) from CVD into the East Fork Russian River. Bachand et al. (2010) found that suspended solid concentration was significantly higher in the East Fork under the low flow conditions that occur during the summer.[514] Leventhal (2010) suggested that turbidity releases from CVD are related to something other than flow such as factors controlling

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[513] SCWA, 2016, *Op. cit.*

[514] Bachand, P.A.M., S.M. Bachand, and R. Leventhal. 2010. The effects of Coyote Valley Dam on the Russian River. Technical memo dated October 4, 2010. 33 pages. Appendix A the 2010 draft report by R. Leventhal, below.

resuspension of sediment in Lake Mendocino.[515] The USACE's examination of turbidity data supports this idea because spikes in turbidity at the CVD outlet occurred that appeared to be unrelated to flow, and because flow and turbidity at the CVD outlet sometimes were moderately correlated, uncorrelated, or negatively correlated depending on the year and season.

Species Effects

Turbidity releases in the spring and summer would be most likely to adversely affect rearing juvenile salmonids in the Russian River mainstem which would be primarily Chinook salmon and steelhead. Elevated turbidity could reduce visibility and impair feeding or the ability to detect predators. Increased energy expenditures would be required if it is necessary to clear sediment from the gills through "flaring," etc. Juveniles closer to CVD would be expected incur the greatest impacts because the turbidity dissipates moving downstream.

Data collected during the lower flow periods of late spring and summer 2012-2014 (i.e., when the CVD outlet contributes most of the flow in the Russian River) indicates that the best case scenarios for juveniles salmonids near the dam may be exposure to 15-17 NTU for the entire low flow period, likely late spring through early fall; the worst case scenario may be exposure to 20-25 NTU, 30-70 NTU or 100-500 NTU for 1-3 week periods during the entire low flow period. Juveniles nearer to Hopland likely would be exposed to 1-10 NTU for the entire low flow period.

USACE (unpublished data) assessed turbidity impact thresholds for rearing juveniles using turbidity data collected from the Russian River watershed and a model from Newcombe and Jensen (1996).[516] Turbidity measurements of 1.7 to 490 NTU were considered sub-lethal and those greater than 490 NTU were considered lethal. Note that there is substantial uncertainty associated with the likelihood of either sub-lethal or lethal effects occurring and their intensity that may cause overestimation of adverse effects for rearing juveniles. This is due in part to the large ranges of turbidity values included in both categories; clearly, adverse impacts are more likely to occur at the higher end of the ranges. USACE notes that most spring and summer measurements at the CVD outlet were less than 100 NTU and often were less than 20 NTU. Additionally, consecutive days of exposure may be required to achieve adverse impacts the data suggest higher turbidity levels (i.e., greater than 100 NTU) may vary by as much as 50 to 250 NTU over 24 hours. Even if effects were assessed over multiple days, Birtwell (1999), in reference to Newcombe and Jensen (1996), warns particularly that caution should be used when "…assessing the effects of low concentrations (≤ tens of mg/L-1) of suspended sediment over protracted periods of time." Fish responses to low levels of suspended sediment are expected to be more variable and have larger "scope for adaptation, tolerance, and resistance."[517] Finally, the threshold between sub-lethal and lethal effects is not well defined and the minimum value was selected for analysis which may overestimate the likelihood of lethal effects. Overall, the

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[515] Leventhal, R. 2010. A preliminary assessment of turbidity in the Russian River related to Coyote Valley Dam at Lake Mendocino. Draft report for NOAA Fisheries. 23 pages plus appendix.

[516] Newcombe, C.P., and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. 16:693-727.

[517] Birtwell, I.K. 1999. The effects of sediment on fish and their habitat. Department of Fisheries and Oceans Canada, Canadian Stock Assessment Secretariat Research Document 99/139, ISSN 1480-4883. Ottawa, Canada. 34 pages.

threshold exceedance values presented below should be considered only as a relative comparison of potential impacts among sites.

Sub-lethal and lethal levels of turbidity just downstream of CVD were present on 89 percent and 6 percent of days, respectively, during the spring and summer. Turbidity levels measured at Hopland were better (i.e., sub-lethal on over 99 percent of days) in that lethal levels were not detected at all. However, a minimum of the sub-lethal threshold being exceeded occurred on 94 percent of the days at CVD versus over 99 percent of the days at Hopland. Turbidity conditions on the West Fork upstream of the East Fork confluence and the effects of CVD inflows were relatively better than those measured at CVD or Hopland in that the sub-lethal threshold minimum was exceeded on a much smaller percentage of days. West Fork turbidity levels were in the sub-lethal range on 35 percent of days and lethal range on less than 1 percent of days in the spring and summer.

For the period 2012-2017, USACE identified and counted the number of days that CVD releases provided most of the flow in the Russian River compared to the contribution from the West Fork which was less than 10 cfs or less than 10 percent of the CVD flow: 2012: 84 days; 2013: 223 days; 2014: 230 days; 2015: 243 days; 2016: 162 days; and 2017: 207 days. The median value for these years is 215 days, which USACE estimates will be the number of days of at least minimum instream flows that the project will provide to the Russian River This is considered a beneficial effect of the project to salmon and steelhead habitat notwithstanding turbidity measurements.

Less is known about turbidity released from WSD into Dry Creek. However, Coho Salmon, Chinook Salmon, and steelhead all occur in Dry Creek and juveniles could be adversely affected by elevated turbidity levels. Dry Creek sometimes is used as a release site for hatchery juveniles. Turbidity levels measured at Lambert Bridge on Dry Creek were in the sub-lethal range on 76 percent of days in the spring and summer.

6.3 Estuary Management

In addition to the natural dynamics of the Estuary, water quality and habitat conditions may be influenced by reservoir operations in the upper watershed. These operations may affect the timing and volume of inflow and therefore affect the conditions of adult movement and juvenile rearing in the Estuary. Furthermore, adaptive management of the Estuary by Sonoma Water ultimately affects the physical beach condition (i.e., closed or open) and therefore will strongly influence water quality and habitat availability. The Proposed Action effects on the Estuary are discussed below.

Importantly, Sonoma Water proposes to offset the effects of beach management these activities by implementing a number of habitat enhancement measures in the Estuary. Sonoma Water will direct the development of conceptual feasibility studies for proposed activities, as well as preparation of CEQA documents and relevant permits. As several projects may be implemented over time, Sonoma Water will direct this process to implement mitigation measures in the short term, while planning for long-term project work that is still developing.

6.3.1 Beach Management

Under the Proposed Action, Sonoma Water would continue to perform adaptive beach management throughout the year, focusing on maximizing salmonid habitat while minimizing flood risk to low-lying properties adjacent to the Estuary. Salmonid spawning habitat is not present within the Estuary or the several kilometers upstream of the Estuary to at least the Mirabel Dam. The Estuary serves as migratory habitat for adult and juvenile passage from and to the ocean, as transition habitat for salmonids smolts, and serves as important rearing habitat for juvenile salmonids, particularly steelhead. Adult salmonids typically immigrate upstream following winter storms, when the Estuary would be open due to natural or artificial breaching.

Under the Proposed Project, breaches would be initiated to minimize flood risk when water surface elevations are expected to exceed 9 ft NGVD. Otherwise, water surface elevations may be allowed to continue below 9 feet NGVD29 if they are expected to persist, and if desired salmonid habitat conditions are being achieved. The lower end of this range can be examined in more detail as part of the ongoing adaptive management, as there may be times when the most desirable habitat outcome would be to breach sooner. However, breaching at a lower water surface elevation comes with a higher risk of an unsuccessful breach (since the hydraulic head through the beach is smaller). When lagoon water surface elevations are in the target range flood risk management is one factor to be considered, along with salmonid life history requirements, in determining whether breaching is appropriate (See Section 3.4.1, *Beach Management*).

6.3.1.1 Adult Salmonid Immigration

Adult salmonids typically immigrate upstream following winter storms when the Estuary would be open due to natural or artificial breaching. Adult salmonids may be delayed from entering the Estuary if drought conditions result in lower inflows that extend closures into October. However, this would take place outside of the period of time that the bulk of adult salmonid migration occurs. In general, thermal conditions are unsuitable for adult salmonids in the Russian River before mid-October (see Section 6.2.5.1, *Water Temperature*). See Section 6.2.3, *Impacts to Estuary Habitats* for a discussion on the effects of water supply operations on Estuary water levels.

Species Exposure and Response

The peak immigration period for adult Chinook Salmon extends from mid-October through mid-December, although migrating adults have been documented at Mirabel in September and November. If Estuary closures extend through October into November and December adult Chinook may be delayed from entering the Estuary. However, video monitoring at Mirabel Dam suggests that in years when the mouth is closed during portions of October, there still exists a sufficient window for adult Chinook Salmon to enter the Estuary and migrate upstream. If beach closures persist through October, and conditions in the river are favorable for upstream migration, Sonoma Water will coordinate with NMFS and CDFW so suitable periods of upstream migration are maximized.

Adult Coho Salmon immigration into the Estuary primarily occurs between November and January. Coho Salmon are most likely to enter freshwater streams to spawn after late-fall or winter rainstorms breach the barrier beach at the river mouth. Closed mouth conditions that extend into November are not expected to result in adverse effects to Coho adults since river water temperatures are likely to be conducive to upstream migration. If breaching occurs later in the Coho immigration period, adults are less likely to be present when conditions are poor for tributary migration and spawning. Additionally, closures during the Coho migration season (November through January) are historically shorter than those that occur earlier in the fall (September and October) because of the higher rates of increase in Estuary water surface elevation. Coho Salmon migrants in the Russian River in early fall may arrive before enough flow is available for migration and spawning in certain tributary streams that presently support Coho. For example, the mouth of Austin Creek is often dry in the late summer and early fall.

Steelhead are the latest arriving of the three salmonid runs, with adult immigration peaking between December and March. As with Coho, extended closures would prevent early migrants from being exposed to stressful water quality conditions in the watershed, particularly in dry years. Importantly, the bulk of steelhead immigration occurs over a period when the Estuary will be naturally open for extended periods in most years.

6.3.1.2 Juvenile Salmonid Rearing

Under the Proposed Project, Estuary water surface elevations would be managed to meet the dual objectives of minimizing flood risk and enhancing habitat based on the conditions considered in the decision trees shown in Section 3.4.1, *Beach Management.* The ecological benefits of naturally functioning lagoons have been documented extensively (see Section 4.4.5, *Russian River Estuary*). NMFS (2008) had previously raised concerns that during the lagoon period the Estuary may not fully convert to freshwater conditions, resulting in stratified conditions that may reduce habitat function and productivity. While inlet closure events can occur in all months, they tend to be most common in spring and fall; and are therefore less common during the summer rearing period. Estuary invertebrate and salmonid growth studies suggest that invertebrate composition is consistent and prey species are abundant regardless of inlet condition.[518] Furthermore, the diet and growth rates of juvenile steelhead does not appear to change based on inlet condition. The high growth rates of juvenile steelhead suggest that prey abundance is not a limiting factor for rearing steelhead survival in the Estuary.

Salmonid smolts migrate through the Estuary in the spring. During spring periods, especially in high precipitation years, flow within the lower Russian River into the Estuary is controlled by natural watershed hydrology rather than reservoir releases. The relationship between minimum instream releases and inflow into the Estuary is discussed above under Section 6.2.3, *Estuary*.. In most years, it is anticipated that unimpaired flows from November through April would be higher than minimum instream flows and similar to baseline under the Proposed Project. Since smolt migration timing would primarily be driven by natural hydrology rather than the instream releases, any effects of the Proposed Action on smolt migration are expected to be negligible.

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[518] Boughton et al., 2017. *Op. cit.*

Habitat Enhancement

As part of the Proposed Action, Sonoma Water will oversee the development and prioritization of a list of habitat enhancement projects, intended to improve rearing habitat for juvenile steelhead in the Estuary. While proposed enhancement sites and restoration actions are in initial planning stages (see Section 3.3.2, *Habitat Enhancement Measures in the Estuary*), potential benefits from enhancement actions for rearing steelhead are discussed below.

Depending on which enhancement actions are implemented, benefits to juvenile steelhead may include providing fish access to long-duration inundated floodplain habitat for high flow refugia and feeding opportunities, by providing complex low-flow shelter elements that juvenile steelhead need during their Estuary rearing period, and by creating complex flow paths and connectivity to adjacent floodplains and constructed tidal channel habitats. The combination of these habitat elements would provide connected, low-predation risk, high-forage opportunity habitats over the Estuary's full range of flow conditions to maximize juvenile steelhead growth and survival.

Floodplain and tidal channel enhancements would be designed to be stable and functional over time and under a wide range of site conditions; they would adapt to the natural fluctuations in tide and streamflow dynamics of the Estuary and would function through climate change driven shifts in sea level, flooding, and temperature. Long-term, these enhancement actions would provide climate resiliency for juvenile steelhead and their habitat by functioning across a wide range of potential tides and sea levels, thereby providing critical refugia and feeding habitat for steelhead in the presence of rising sea levels and increased frequency of extreme weather events.

While not the target of these enhancement actions, they will also benefit juvenile Coho and Chinook Salmon in similar ways to those outlined above. Increased access to long-inundated floodplain habitat may also benefit spawning and rearing longfin smelt in the Estuary. Overall, these enhancement actions will benefit biodiversity by providing transitional habitat that ranges across elevations, from upland to river, and is adaptive to changes in inundation patterns. Increased frequency and duration of inundation of the floodplains will also benefit wetland species biodiversity and will likely benefit a range of other species that are not explicitly targeted by the enhancement, including special-status plants, insects, reptiles, amphibians, and resident and migratory birds.

6.3.1.3 Effects of Flushing

Under certain conditions, breaching of an estuary beach barrier can lead to a rapid outflow from the estuary and high velocity flows may flush many small fish from the estuary, including young salmonids, or leave them stranded on exposed.[519] Additionally breaching may force juvenile

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[519] Swift, C.S., Mulder, J., and C. Dellith. 2018. Mortality of native and non-native fishes during artificial breaching of coastal lagoons in southern and central California. Bulletin of the Southern California Academy of Sciences 117 (3), 1-12.

salmonids (most notably steelhead) to enter the ocean before they are physiologically ready, removing them from food-rich habitats, and exposing them to ocean predation.[520]

Under current the beach management program, no stranding of juvenile steelhead has been observed during the flushing period. Nor has any significant water quality impairment resulted such that adverse effects to steelhead were observed. It is likely that the effects of flushing during a managed outlet condition and those that occur during natural breach events are similar. Furthermore, anadromous salmonids within intermittently closed estuaries have adapted physiological, metabolic, and/or behavioral mechanisms to survive in these dynamic systems.[521] Under the Proposed Action, the Estuary will be managed to limit actions during the spring months (March through June) when YOY steelhead typically begin arriving in the Estuary from upstream. Maintaining inlet closure events with lagoon water surface elevations approaching the 9-foot NGVD29 stage allows juveniles to acclimate to higher salinities and increase in size before reaching the ocean. Thus, impacts from flushing on steelhead are expected to be negligible under the Proposed Action.

6.3.1.4 Salmonid Predation Risk

Limited information exists relative to the confounding factors associated with predation risk (or avoidance) and foraging behavior of riverine or estuarine rearing salmonids. However, it is commonly inferred in aquatic ecology that individual fish (*i.e.,* salmonids) are often confronted with weighing the gross benefits of exploiting high growth potential areas and feeding opportunities with the risk of being susceptible to avian and/or other aquatic predation. The extent to which predation may be occurring and therefore impacting survival is unknown in the Estuary; however, the literature suggests that in cases where food is abundant and readily accessible, individuals are unlikely to be exhibiting risky foraging behavior.[522,523] Whether or not foraging opportunity has a greater influence on depth preferences than predator avoidance, predation risk may influence habitat use and the potential consequences of that risk on the populations. Based on a review of predation literature, Boughton et al. (2017) developed conceptual foraging habitat zones for the Russian River Estuary, organized by depth, each with associated predation risks (**Table 6-35**).[524]

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[520] Parkinson, M. and D. Stretch. 2006. Breaching timescales and peak outflows for perched, temporary open estuaries. Coastal Engineering 49(3), 267-290.

[521] von der Heyden, Sophie & Toms, Jessica & Teske, Peter & Lamberth, Stephen & Holleman, Wouter. 2015. Contrasting signals of genetic diversity and historical demography between two recently diverged marine and estuarine fish species. Marine Ecology Progress Series. 526. 10.3354/meps11191.

[522] Dill, L.M. 1983. Adaptive flexibility in the foraging behavior of fishes. Canadian Journal of Fisheries and Aquatic Sciences 40: 398-408

[523] Dill, L.M., and A.H.G. Fraser. 1984. Risk of predation and the feeding behavior of juvenile coho salmon (Oncorhynchus kisutch). Behavioral Ecology and Sociobiology 16:65-71.

[524] Boughton et al., 2017. *Op. cit.*

TABLE 6-35
CONCEPTUAL HABITAT ZONES FOR FRESHWATER- AND MARINE-ACCLIMATED RESIDENTS

Zone Depth	Total Depth	Habitat Conceptual Zone	Foraging Habitat	Predation Risk
0 – 1 meter	< 1 m	Shallow/ Shoal Littoral	Sunlight penetrates to bottom (high prey availability)	Shallow water risk: High avian predation risk, Low aquatic predation risk
0 – 1 meter	> 1 m	Surface Limnetic	Within depths of sunlight penetration (low prey availability)	Shallow water risk: High avian predation risk, High aquatic predation risk
1 – 5 meter	> 1 m and ≤ 5 m	Subsurface Epibenthic	Below surface foraging zone; within depths of sunlight penetration (high prey availability)	Subsurface open water risk: Low avian predation risk, Moderate aquatic predation risk
1 – 5 meter	≥ 5 m	Subsurface Limnetic	Below surface foraging zone; within depths of sunlight penetration (low prey availability)	
5 meter to bottom	≥ 5 m	Profundal (Stagnant)	Little or no light penetration and poor circulation (low prey availability or unsuitable due to hypoxia/anoxia and low light levels)	Unoccupied/no predation risk

SOURCE: Boughton et al. 2017

Species Exposure and Response

The Proposed Project is not anticipated to adversely affect the quantity or quality of salmonid habitat in the Estuary. However, lower inflows into the Russian River Estuary may prolong the length of closures. Observations of recent prolonged closures and recent modeling results suggest that the Estuary may not fully convert to a freshwater lagoon.[525,526] Recent fish monitoring, and two-dimensional hydraulic modeling results suggests that a stratified lagoon provides ample rearing habitat as the fresh water surface layer thickens and inundates previously dry shoreline.[527,528] Avian predation would not likely increase from the baseline conditions. This is because the duration of closures may increase which would lead to a thicker freshwater lens in the Estuary that would provide steelhead with more freshwater depth to avoid avian predation. There would be no negative effects to the quantity and quality of juvenile steelhead habitat that could make juvenile steelhead more susceptible to avian predation. Salmonids in the Estuary likely face predation pressure from marine mammals regardless of the condition of the barrier beach (i.e., open or closed). Under a closed mouth condition, seals and sea lions forage off the coast of the beach and may prey on adult fish holding in offshore waters prior to breaching. Conversely,

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525 Largier, J., and D. Behrens. 2011. Hydrography of the Russian River estuary summer-fall 2009 with special attention on a five-week closure event. Davis: UC Davis.

526 Bombardelli, F.A., D. Behrens, S. Hedge, K. Hewett, J. Largier, and G. Sahoo. 2014. Final Report: Modeling seawater intrusion and trapping in the Russian River Estuary. Davis: University of California, Davis.

527 Matsubu, B., G. Horton, D. Beauchamp, and C. ("Si") Simenstad. 2015. "Trade-offs of juvenile steelhead (Oncorhychus mykiss) rearing in an intermittent estuary, Northern California (Oral Presentation)." Santa Rosa, CA: University of Washington, December 21.

528 Seghesio, Erin E. 2011. The Influence of an Intermittently Closed, Northern California Estuary on the Feeding Ecology of Juvenile Steelhead (Oncorhynchus mykiss) and Chinook Salmon (Oncorhynchus tshawytscha). Arcata: Humboldt State University.

under an open mouth condition seals and sea lions may anticipate breaching events and opportunistically prey on out-migrating fish. It is unknown whether open or closed mouth conditions present a greater predation risk on salmonids.

6.3.1.5 Longfin Smelt

As described in Section 5, Longfin Smelt detections in the Estuary have been infrequent, and as a result, their status and habitat associations are uncertain.[529,530,531] Brennan et al. (2022)[532] hypothesized that shallow tidal wetlands and sloughs likely promote larvae retention based on their presence in larger estuaries with these habitat features, where detections were more reliable. The study also concluded that high flows may transport larvae out of smaller coastal estuaries, including the Russian River, thereby reducing detectability.[533] This process would be expected to occur naturally, under the baseline, and under the Proposed Action based on the seasonal hydrology, hydraulics, and geometry of the Russian River Estuary.

Within the estuaries surveyed as part of the Brennan et al. (2022) study,[534] salinity and turbidity most strongly influenced the likelihood of larval presence, increasing with turbidity and decreasing with salinity—conditions that are typical of higher freshwater outflow. As described in Section 4 and above, the Russian River Estuary exhibits dynamic conditions associated with seasonal precipitation and associated outflow, and beach barrier closures and openings. These include variable fresh, brackish, and marine salinity conditions in the upper to lower reaches of the Estuary. Under the Proposed Action, including adaptive beach management, these conditions would continue to be dynamic and variable.

While there are ongoing data collection efforts in the Bay-Delta, there is currently little study of populations outside of that area, including the Russian River Estuary. Garwood (2017)[535] identified that systematic studies are needed throughout its range in California to inform the management of this species. This type of effort could likely be accomplished with newer methods such as environmental DNA (eDNA) currently being utilized to detect other listed cryptic aquatic species.[536] This would provide a comprehensive and contemporary view of Longfin Smelt presence to prioritize research and management needs for the species.[537] Future investigations should also determine spatial and temporal habitats and areas important to the species. In order to address the uncertainties identified above, Sonoma Water proposes to develop and implement, in consultation with CDFW, an eDNA monitoring program focused on Longfin Smelt in the Estuary. The effort could include habitat stratification and eDNA sampling informed by existing understanding of Estuary hydrology, water quality, and physical habitat dynamics. Because

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[529] Garwood RS. 2017. *Op. cit.*

[530] Brennan et al. 2022. *Op cit.*

[531] Brennan, C., personal communications. 2022. *Op cit.*

[532] Brennan et al. 2022. *Op cit.*

[533] Brennan et al. 2022. *Op cit.*

[534] Brennan et al. 2022. *Op cit.*

[535] Garwood RS. 2017. *Op. cit.*

[536] Garwood RS. 2017. *Op. cit.*

[537] Roni, P., t. beechie, R. biLby, F. Leonetti, M. PoLLock, and G. PeSS. 2002. A Review of Stream Restoration Techniques and a Hierarchical Strategy for Prioritizing Restoration in Pacifc Northwest Watersheds. *North American Journal of Fisheries Management* 22(1):1-20.

eDNA monitoring is passive (i.e., collection of water samples for DNA extraction), it would not involve capture or handling of individuals, and therefore, there would be no effects on the species associated with this activity.

6.3.1.6 Adaptive Management

The Proposed Action includes an adaptive management element designed to reduce the likelihood of additional impacts to fish species through a range of monitoring, assessment, agency consultation, and management actions. The Adaptive Management Plan and decision tree developed for the Proposed Action includes consideration and monitoring of biological productivity, water quality, and physical processes in the Estuary in response to changes in water surface elevations in the estuary-lagoon system; and refinement of management actions to achieve desired water levels to support biological productivity, while simultaneously minimizing flood risk for low-lying properties adjacent to the Estuary. The adaptive management of future conditions in the Estuary will be closely coordinated with NMFS and CDFW staff.

Importantly, adaptive beach management will continue to be conducted in consideration of different salmonid life stages throughout the year (See Section 3.4.1.1, *Management Considerations*). The ability of Chinook and Coho salmon smolts to emigrate in the spring will be an important factor in determining whether breaching is necessary (see Section 3.3.1.1, *Management Considerations*). Additionally, management actions will be limited in the Estuary during spring months (March through June) to support juvenile steelhead rearing. Likewise, during the summer months, the Estuary will be managed to support estuarine habitat conditions. Lastly, during fall and winter, if the inlet is closed but conditions in the river are favorable for upstream migration, Sonoma Water will consider breaching to maximize the time available for immigration. Incorporating these life history considerations into Sonoma Water's actions in the Estuary will ensure that future management results in negligible adverse effects on Chinook Salmon, Coho Salmon, and steelhead.

6.4 Channel Maintenance

As described in Section 3, Sonoma Water will continue to conduct channel maintenance in Dry Creek associated with operation of WSD. In the Russian River, MCRRFC&WCID will continue to conduct channel maintenance activities within Mendocino County. No channel maintenance activities are proposed on the Russian River by Sonoma Water as part of the Proposed Action. On Dry Creek, Sonoma Water, via USACE authorization, will continue to maintain the 14 remaining bank stabilization sites in Dry Creek which have a total linear extent of approximately 1.6 km. These include flexible fence training structures, wire mesh and gravel revetments, pervious erosion check dams, rock bank, board fencing, erosion control sills, and concrete weirs. Some of these structures only require inspections while others may require maintenance such as bank repair or structure maintenance/repair.

6.4.1 Species Exposure and Response

The potential impact on salmonids from maintenance activities differs by activity. Maintenance activities that occur outside of flowing and/or stream channel are expected to have no effect on salmonids. These consist of vegetation management and some streambank stabilization activities. Channel maintenance activities that could negatively impact or beneficially effect salmonids include debris removal, minor bank stabilization, and other, small instream ground disturbing activities that may directly affect salmonids through temporary loss, fragmentation, and degradation of habitat.

Removal of riparian vegetation has the potential to reduce cover, increase water temperatures, and reduce the amount of aquatic invertebrates, which are the primary food source for salmonids. In addition, vegetation loss will likely reduce the sediment filtration capacity where vegetation removal occurs. This, combined with ground disturbance in maintenance areas, may cause localized sedimentation of spawning gravels. Increased fine sediments in spawning gravels reduce the quality of the substrate for incubating eggs by decreasing the amount of dissolved oxygen available to them. The barrier used to prevent downstream turbidity and sedimentation may increase these impacts in localized areas adjacent to the bank repair sites. However, this impact is minimized with the development of a mature riparian canopy by selective tree trimming and removal, targeted removal of invasive plants, and revegetation with native plants. The loss of in-stream cover, such as rocks and large woody debris, would impact potential refuge for migrating adult and over-summering juvenile salmonids.

Lastly, herbicides will only be applied above the ordinal high-water mark along creeks and targeted application can be effective without harming aquatic environments (see description of BMPs in Section 3). All herbicide use will comply with application regulations, including the Federal Insecticide and Fungicide Act, and all pesticide applicators will be certified by the state. Currently, Sonoma Water applies AquaMaster®, which contains glyphosate as the active ingredient, to access roads along Sonoma Water-maintained channels. As part of tree removal activities within maintenance channels, AquaMaster® is applied primarily on cut willow stumps by hand. Sonoma Water may also apply AquaMaster® to control problematic blackberry patches. The herbicide would be applied with a truck mounted sprayer with a hose reel or backpack sprayer after initial mechanical removal. Importantly, herbicide use is minimal and applied only after primary methods such as mechanical removal and mowing are used for managing problematic vegetation.

Sonoma Water and MCRRFC&WCID have incorporated several minimization and avoidance measures to protect salmonids.[538] These measures were developed in collaboration with state and federal agencies and were part of the previous Russian River Biological Opinions issued by NMFS. Mitigation measures include several pre-maintenance approaches to avoid and minimize impacts through site planning, timing of work to avoid presence, consideration of site resources, and understanding stream processes. There are several BMPs that conserve salmonid resources, including minimizing ground disturbance activities, fish relocation, management of invasive plants, revegetation, soil erosion control, and maintaining channel habitat features.

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[538] SCWA, 2021. *Op. cit.*

Several of the channel maintenance activities will likely benefit salmonids and improve the ecological function of the Dry Creek watershed. The following are potential benefits to salmonid habitat that are achieved through periodic channel maintenance:

- Development or enhancement of a mature riparian canopy to improve water quality through shading and increase habitat complexity where it is currently either degraded or non-existent.
- Reduction of invasive and exotic species (including water primrose [*Ludwigia*]) within Dry Creek to improve movement of aquatic species and improve water quality (i.e., dissolved oxygen, etc.), and nonnative shrubs and trees that compete with native riparian species).
- Reduction of erosion and sediment loading through repair of destabilized banks to reduce the potential negative effects of turbidity on rearing and/or migrating fish.
- Reduction of the frequency and intensity of future in-channel maintenance through low-impact periodic maintenance actions.

Overall, impacts would be generally limited to small-scale effects related to sediment input to the creek and some small amount of vegetation removal. Importantly, ground-disturbing activities, including those that may occur within or adjacent to a wetted channel, are expected to be minimal. It is unlikely that any channel maintenance actions would result in adverse effects on aquatic habitat or salmonids. Effective implementation of project BMPs significantly reduces the risk of short-term effects. Therefore, both short-term, direct effects to salmonids and salmonid habitat would be negligible.

6.5 Central Sonoma Watershed Project

These reservoirs and diversion structures operate passively, *i.e.*, they were constructed to require no operational activity. Maintenance activities at these reservoirs are covered under a separate SMP Biological Opinion, and, in most cases, unlikely to adversely affect salmonid habitat or salmonids. Under the Proposed Action, Sonoma Water would continue to operate the Santa Rosa Creek diversion structure. During normal operating conditions, Santa Rosa Creek flows would pass through the Vortex Tube and the Bypass Pipe ends would be closed. The Bypass Pipe would only be placed into operation during Vortex Tube repair work to allow periodic future inspections of the integrity of the Vortex Tube if visible damage is observed, and to conduct maintenance, as needed. During inspections, fish passage between the diversion structure and Santa Rosa Creek would be maintained through the Bypass Pipe. Thus, no impacts to fish are anticipated during this period.

The *2008 Biological Opinion*, and its preceding BA, included evaluations on whether passive operation of the Santa Rosa Creek Diversion Structure had been resulting in the entrainment and diversion of steelhead. These documents identified a low risk of entrainment and diversion of steelhead into Spring Lake during peak flow events (see Section 3.5.1, *Santa Rosa Creek Diversion Structure*). [539,540] The BA identified that storm events, with flows high enough to enter Spring Lake through the diversion structure, generally occur in January and February. However,

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[539] SCWA, 2020. *Op. cit.*

[540] No Chinook or Coho Salmon are present within the Santa Rosa Creek watershed.

after March, storm events of this magnitude are less frequent. Importantly, only approximately one storm event per year would be high enough for water to spill through the diversion structure to Spring Lake. These events would occur only for a few days in most years, and many would occur prior to the steelhead downstream migration period. Thus, the risk to the population of steelhead is low because only a fraction of the smolt-sized fish that would migrate during a single storm would be affected. Additionally, only one storm per year results in flows high enough to divert to Spring Lake, and the overlap between the juvenile steelhead migration period and the period of time water is most likely to spill to Spring Lake is of a short duration.

6.6 Hatchery Operations

The Coho Salmon broodstock and steelhead hatchery programs are currently authorized, or in the process of seeking authorization, under individual Federal ESA section 10(a)(1)(A) enhancement permits. Since the effects of operation of the Coho Salmon broodstock program have already been analyzed by NMFS in a July 2020 Final Environmental Assessment, and the federal permit for the broodstock program has been issued, the coverage of specific program elements will not be sought as part of the Proposed Action in this Biological Assessment.[541] While not complete, a similar process is underway for the steelhead hatchery program.

6.7 Dry Creek Habitat Enhancement

As described under Section 4.4.4, *Dry Creek Enhancement* the full six miles of enhancement, as stipulated under the *2008 Biological Opinion*, were not completed by Sonoma Water and USACE within the allotted 12-year period. Failure to meet enhancement targets could result in adverse effects on salmonids by limiting the availability of winter and summer rearing habitats for juvenile steelhead and Coho Salmon. This reduction in available habitat could result in increased competition for resources within the limited amounts of winter and summer rearing habitats and thereby impair juvenile survival rates for both species.

However, monitoring conducted in Dry Creek suggests that Coho and steelhead abundance is not currently limited by the availability of instream rearing habitat. Based on recent validation monitoring, there is clear evidence that juvenile salmonids are utilizing much of the completed 3.4-miles of habitat enhancements in Dry Creek (See Section 4.4.4.2, *Dry Creek Habitat Enhancement Monitoring*). However, the densities of juvenile steelhead and Coho Salmon observed within the enhancement sites do not appear to be near carrying capacity or at a level that would suggest impacts on survival from increased competition for resources (see Table 4-18). Therefore, it is unlikely that the lack of compliance with the Dry Creek RPA element in *2008 Biological Opinion* is resulting in adverse effects on steelhead or Coho Salmon.

6.7.1 Temporary, Construction-related Effects

The primary action area for this effects analysis includes all the reaches and subreaches of Dry Creek proposed for restoration (1, 2a, 4b, 4c, 5b, 10, 13a and 13b) and their adjacent riparian zones. Discussion of direct and indirect effects is organized by 1) temporary, construction-related

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[541] NMFS, 2020. *Op. cit.*

effects and 2) long-term effects associated with enhancements. Indirect effects on conditions within the greater Dry Creek (e.g., up or downstream) of the proposed reaches and subreaches also fall within the scope of analysis in some cases.

6.7.1.1 Suspended Particulates and Turbidity

Water clarity can be affected by releases of solids into a stream course and by the disturbance of sediments within the stream from streambed alteration or modification activities. Turbidity is a measure of the clarity of the water column, and more turbid conditions are generally associated with elevated levels of suspended and settleable particulates in the water column.

Construction activities associated with the Proposed Action would likely induce temporary increases in suspended and settleable particulates in the main Dry Creek channel. But the impact of these increases is expected to be negligible. Sonoma Water's 2014 Dry Creek Demonstration Project (Mile 1) consists of features similar to those associated with the Proposed Action (e.g., secondary channel features, large wood structures) and thus provides a good indication of the type of impact that could be expected under the Proposed Action. During construction of the Demonstration Project, turbidity was monitored at the same site below the Lambert Bridge stream gauge, which is at the downstream end of the Demonstration Project reach.

Brief increases in suspended particulates and resulting spikes in turbidity were observed on several days. They typically lasted from several minutes to a few hours following each occurrence. These elevated turbidity levels during construction were generally associated with times when creek flow was initially introduced into a habitat feature area after it was constructed. Despite such brief spikes of turbidity, daily median turbidity values were not significantly affected relative to those recorded in 2012 and 2013 (prior to project construction), illustrating the short-term nature of the effect. Moreover, no long-term chronic effects were observed, as daily minimum turbidity values during the 2014 construction season continued to be consistent with daily minimum values observed before and after construction of the Demonstration Project.

Similar to construction of the Demonstration Project, construction of the reaches and subreaches associated with the Proposed Action will likely result in temporary increases in suspended particulates and thus turbidity on the order of several minutes to hours, largely during the connection of newly constructed off-channel restoration features to the main stem. The proposed enhancements would be phased such that separate groupings of a few reaches and subreaches will be constructed concurrently over approximately 3 years, with major ground-disturbing activities near the channel limited to the July 15- October 15 low-flow period each year. This phasing would help limit any increases in turbidity associated with the Proposed Action because activities that might induce temporary spikes in turbidity would not occur all in one year.

Additionally, the Proposed Action includes bank stabilization components in the restored reaches and subreaches to minimize erosion in the newly constructed, off-channel restoration features. This would help reduce the suspension of particulates from these features into the channel. Turbidity curtains may also be used as part of the Proposed Action as appropriate to separate in-channel work areas from the main channel. As was the case with the demonstration project, any potential increases in suspended particulates are not anticipated to affect daily median turbidity or result in long-term effects on minimum turbidity.

Construction activities associated with the Proposed Action also have the potential to indirectly affect turbidity and suspended particulates during the construction period because of increased surface runoff and erosion carrying particulates into the channel. To minimize the potential for the contribution of particulates from such runoff during construction the construction would be phased as described above, and major ground-disturbing activities would be limited to the typical dry season in-water work period (June 15 through October 15) in each year of construction. Other work such as clearing and grubbing in the reaches and subreaches under construction each year may be conducted outside of this work period timeframe.

As discussed above, the Proposed Action would include implementing BMPs to minimize surface runoff and erosion. Erosion-control practices and dust-control measures would also be implemented within the proposed construction action areas and staging areas to minimize water or airborne release of sediment or particulates into the channel. The chosen construction contractor would also be required to obtain and comply with a necessary National Pollutant Discharge Elimination System (NPDES) permit and prepare a storm water pollution prevention plan (SWPPP) prior to initiating construction.

Only temporary, short-term increases in suspended particulates and turbidity are anticipated during construction or maintenance of the Proposed Action. BMPs would be implemented to minimize particulate contributions from construction activities. Operation of a constructed project (e.g., water flowing through constructed features in the future) is expected to result in negligible changes in turbidity or suspended particulates. Thus, any impacts on water quality because of suspended particulates and turbidity would be limited to short periods during construction or maintenance activities and, given the proposed BMPs, is expected to have negligible effects on instream habitat and salmonids.

6.7.1.2 Temperature and Dissolved Oxygen

Water temperature in Dry Creek mirrors the temperature of the water released from Lake Sonoma, which is regulated along with flows to be suitable for fish hatchery operations. As indicated above, temperatures were observed to range from 54 to 62° F at the Lambert Bridge stream gauge between 2012 and 2014. DO content for the same period ranged from 8.8 mg/L to 12.2 mg/L.

The Proposed Action has the potential to affect temperature and DO through the suspension of sediments and removal of riparian vegetation providing shading, which can affect these parameters. The spikes in suspended sediments and turbidity as well as the removal of overhanging riparian vegetation associated with the Dry Creek Demonstration Project in 2014 were not observed to cause significant changes to temperature and dissolved oxygen concentrations. Temperatures and dissolved oxygen concentrations at the Lambert Bridge stream gauge during the 2014 construction season were observed to remain consistent with temperature and DO concentrations recorded before and after the Demonstration Project construction activities. Temperature and dissolved-oxygen concentrations in 2014 also remained consistent with seasonal concentrations recorded during 2012 and 2013.

Post-construction, off-channel restoration features associated with the Proposed Action would be expected to have similar water temperature and DO parameters to those existing in Dry Creek currently. Water velocity through the off-channel restoration features is designed to be rapid enough to prevent nuisance sedimentation or increased water temperatures because of greater exposure to thermal radiation. Depressional features (e.g., alcoves) would be hyporheically connected (i.e., connected through groundwater inputs) to Dry Creek as well, and since hyporheic inputs are typically cooler than surface flow in rivers and streams, these features would be expected to remain cool. Additionally, the Proposed Action includes replanting of native vegetation along the newly graded features and placement of LWM structures which would help provide cover over the new features to keep temperatures low in the constructed features.

Given the volume of cold water coming out of Lake Sonoma, the minimal and temporary increases in turbidity and loss of riparian screening expected during construction or maintenance of the Proposed Action, and the expected similarity in water quality parameters between Dry Creek and the newly constructed restoration features, the Proposed Action is not anticipated to have a substantial effect on temperatures and DO in the action area or greater Dry Creek.

6.7.1.3 Pollutants

Construction activities in the vicinity of surface waters have the potential to introduce pollutants into water courses and affect water quality. Avoidance and minimization measures would be exercised throughout implementation of the Proposed Action to ensure debris, rubbish, petroleum products, or other materials from construction or associated activities do not enter the water or affect water quality in Dry Creek.

Storage, maintenance, and staging of equipment would be limited to designated staging areas for each reach or subreach and will be conducted in a manner that will not result in a discharge of any substance into Dry Creek. Fueling of equipment would occur at an appropriate off-site facility or in designated locations in staging areas and would be implemented in a manner designed to ensure no pollution occurs (e.g., with secondary containment). Although spills are unanticipated, spill-response equipment would be stored onsite for immediate implementation to minimize the impacts of any accidental spills. At the completion of construction, all construction wastes, debris, sediment, rubbish, trash, fencing, and materials would be removed from the sites and transported to an authorized disposal area to prevent any materials from entering the waters of Dry Creek. Given these avoidance measures, the Proposed Action is not expected to have any significant adverse effects on water quality from pollutants.

6.7.1.4 Contaminants in Excavated or Fill Material

Approximately 200,000 cy of earthen material would be excavated for construction of the restoration features associated with the Proposed Action over an approximately three-year period. Excavated earthen material from the project sites would be stored onsite or in the proposed staging areas to be used as a bank stabilization and fill for other restoration features associated with construction activities where possible. No contaminants are expected in any of the material onsite under the Proposed Action. Moreover, the material excavated onsite is expected to provide enough supply to construct the proposed features onsite, so that no additional material will need to be borrowed and brought to the site. Because the source and receiving sites would be the same, the fill material would be compatible (e.g., in terms of grain size and composition) with the site.

If, although unexpected, additional fill material were necessary for the Proposed Action the additional material would undergo appropriate testing to ensure it was free of contaminates and compatible with the placement sites. Similarly, if any material were leftover at the end of construction of the Proposed Project, disposal of such material would be at an appropriate location. Any material from the reaches and subreaches proposed for restoration under the Proposed Action is expected to be suitable for a class III landfill. In the unlikely event that materials were found to be unsuitable for class III they would be disposed of at the appropriate class landfill (II or I) as applicable.

In addition to soil material, logs, boulders, and riffle material (gravel, cobbles, sand) would be placed in the main and side channels to create restoration features as part of the Proposed Action. Large wood features would be constructed from trees felled onsite or with imported large logs. Such logs would be natural material, inspected for pests, and not anticipated to introduce any contaminants to the site. Similarly, boulders and riffle material would be appropriately selected mineral types to be compatible with rock types and conditions in the action area. These natural materials would not introduce contaminants to the site. Given that the soil onsite is not known or anticipated to have any contaminants; material excavated from the site is expected to supply the proposed construction of other features onsite; the proposed suitability testing of any material to be imported to the site (although this is considered unlikely); and the natural, inert nature of the logs, boulders, and riffle material to be used to construct in-channel restoration features, the Proposed Action is not anticipated to have any significant effects related to contaminants in dredge or fill material.

6.7.2 Species Exposure and Response

6.7.2.1 Direct Disturbance to Salmonids

Construction of instream restoration features could potentially affect the movement of adult or juvenile Coho Salmon, Chinook Salmon, and steelhead through the immediate work area (e.g., if an area were isolated from flows using a cofferdam). Construction in or near the streambed would occur between June 15 and October 15 of any given construction year. Adult Chinook Salmon may be present in the proposed restoration reaches and subreaches; however, the proposed construction period is in the early portion of the Chinook Salmon run in Dry Creek and instream work would be complete before the peak upstream migration periods for Coho Salmon, Chinook Salmon, and steelhead. Juvenile steelhead, Coho Salmon, and to a lesser degree Chinook Salmon, could be present within the proposed restoration reaches and subreaches during these months. However, it is expected that construction would be phased over a few years and only partial flow diversion would be required for construction activities and creek flow would be allowed to continue in the channel adjacent to the isolated area so salmonids could access a large amount of aquatic habitat within Dry Creek. If complete dewatering from bank to bank were necessary, fish located within the section of the channel to be completely dewatered would be removed and relocated to appropriate habitat downstream of the project site by qualified fisheries biologists using methods approved by the appropriate resource agencies. In some instances, such as placement of instream boulders, work in the flowing stream may occur as it would be less disruptive than isolating the work area from the flowing stream.

Placement of in-stream features could temporarily startle fish nearby causing them to avoid the area. However, this effect would be extremely short-term and not substantial given the amount of additional habitat along Dry Creek available.

Only a small portion of existing potential salmonid spawning habitat within Dry Creek occurs within the reaches and subreaches proposed for restoration under this Proposed Action and therefore, the potential for instream construction activities associated with the Proposed Action to adversely affect such spawning habitat usage and quality is negligible. Moreover, the Proposed Action would be expected to restore potential spawning habitat (e.g., riffle habitat) in the subreach over the long-term; a benefit that would offset any potential temporary adverse effects.

The June 15 to October 15 work window would coincide with juvenile rearing periods for Coho Salmon and steelhead in the areas proposed for construction. Because Chinook Salmon do not rear over the summer in the Dry Creek system, construction activities are not expected to result in any effects to juvenile Chinook Salmon. Most restoration features included as part of the Proposed Action are off-channel and adjacent to the existing active summer flow area of the creek. Additionally, construction of any of the enhancements would be phased such that only a few reaches or subreaches are under construction each year. Thus, the total area of existing rearing habitat that may be unavailable due to construction activities would be minor compared to the remaining available rearing habitat area within Dry Creek. Adverse effects to salmonid rearing habitat are not expected from the Proposed Action. The primary outcome of the enhancement project would be to restore summer rearing and winter refuge habitat for juvenile Coho Salmon and steelhead.

6.7.2.2 Long-term Effects Associated with Enhancements

Instream Habitat

While construction and maintenance activities associated with the Proposed Action are likely to temporarily affect existing aquatic habitat within the reaches and subreaches proposed for enhancement, the projects would have long-term beneficial effects on aquatic habitat by restoring the quality and area of habitat in Dry Creek.

Over the long-term, the Proposed Action would result in a large increase in the area and complexity of aquatic habitat throughout Dry Creek (below WSD). This would be the primary long-term, beneficial effect of the Action, as the enhancement actions will restore side channel and winter refuge habitat types that are currently absent from many of the subreaches and would increase backwater/alcoves and riffle/boulder field habitats (see Section 3.8, *Dry Creek Habitat Enhancement*). In a number of the reaches and subreaches, existing riffle habitat in the main channel would be enhanced with appropriate gravel substrate, which is intended to also enhance the adjacent pool habitat by slowing pool velocities. Installation of erosion control brush mats and revegetation with native riparian species as part of the Proposed Action would benefit aquatic habitat quality by reducing chronic erosion in critical locations and providing additional shading along the channel margins. Large woody structures and boulders would also benefit aquatic habitat by increasing complexity, slowing velocities in the channel, providing cover, and creating areas of aquatic substrate on which macro-invertebrates can attach. Moreover, the Proposed Action would enhance connections between the mainstem of Dry Creek and tributary connections in certain reaches and subreaches, which are important transitional habitats.

Restoration features such as large woody debris would provide places for juvenile Coho and steelhead to avoid predators, escape high water velocities, and find food. Although Chinook Salmon juveniles spend a relatively short time (compared to Coho and steelhead) rearing in freshwater before migrating to the ocean, they would likely benefit from habitat enhancement as well because of the increased shelter opportunities the habitat features would provide. Previously constructed restoration features (e.g., off-channel steelhead and Coho habitats) are monitored by Sonoma Water to verify habitat use and document density. The primary methods for this monitoring are snorkel and electrofishing surveys. See Section 4.4.4.2, *Validation Monitoring* for the results of those monitoring efforts.

In-stream and off-channel restoration features associated with the Proposed Action would also likely assist with migration of anadromous species during moderate to high flows by providing hydraulic and escape cover. These features would provide resting places for upstream migrating adult salmonids where no resting places currently exist, likely improving migration success within and through the Proposed Action area to potential spawning habitat in Dry Creek and in tributaries. Thus, the Proposed Action would provide a benefit to upstream migrating adult Coho, Chinook, and steelhead.

6.8 Interrelated and Interdependent Effects

6.8.1 Diversion Facilities

Sonoma Water proposes to continue to operate and maintain the diversion facilities at Mirabel and Wohler described in the Environmental Baseline section. Potential effects associated with operation of these facilities, or components of these facilities, that may result in adverse effects on salmonids and their habitat are described below.

6.8.1.1 Habitat Effects

Inflation and deflation of the dam decrease the river stage above and below the dam, creating the potential for fish stranding upstream and downstream of the dam. As the dam is deflated, water levels decline upstream of the dam. Flow recession occurs from the dam to approximately 5.1 stream km upstream. Flow fluctuations due to inflation/deflation occur on average only 3 times per year. When the dam is inflated, it begins to impound water and flow is reduced downstream. Inflating the dam will also change the water level downstream until stable flow through the ladder is established.

Before the dam is raised, it is sometimes necessary to remove gravel that has accumulated on top of the dam and in the fish ladders as the result of bed movement during winter. Grading and removal of gravel would only be required after large depositional events following high flow periods. Gravel removal would only occur in areas that are not inundated by the active flow of the Russian River or in areas that can be isolated from the active flow of the Russian River. Similarly, all equipment would remain outside the active channel. Importantly, grading will no longer be conducted to improve infiltration capacity. Since no grading will occur in the active channel, impacts to water quality as a result of temporary increases in turbidity will not occur.

The infiltration ponds, which are isolated from the Russian River by levees, occasionally flood during flooding events. During flooding events salmonids (other fishes and potential predators) may be trapped in the ponds as water levels recede. The ponds are predicted to overtop only during December through March. Water diversion intakes at Mirabel are screened to prevent fish entrainment and were replaced in 2016 by Sonoma Water to meet NMFS criteria for screen openings.

NMFS has previously raised concerns about the effects of the inflatable dam on water quality. Sonoma Water monitoring of DO in the Wohler Pool has found that DO levels typically range from 6.7 mg/l to 9.0 mg/l – slightly lower than DO levels at the upstream control sites.[542] Initial distress symptoms for salmonids occurred at DO levels of 6.0 mg/l – 7.0 mg/l.[543,544,545] Low dissolved oxygen levels can negatively affect metabolic function, swimming, and overall survival of salmonids. Small temperature increases above natural warming occur in the Wohler Pool impoundment (upstream of the dam). This would be most critical during summer months. Importantly, summer water temperatures upstream of the impounded area are naturally high, and it is likely that poor rearing conditions may occur in this part of the main stem during the hottest part of the summer, regardless of the presence of the Wohler Pool.

The aquatic habitat at the inflatable dam site does not provide good quality rearing habitat for salmonids, as described in Section 4, *Environmental Baseline*. When the dam is inflated, a 4.8-km long pond like environment is created in the Russian River. Pond conditions are likely to diminish the value of this reach as salmonid habitat, by: preventing the establishment of emergent riparian vegetation, reducing the ability of the river to cool at night (in the pond), and improving habitat conditions for known salmonid predators (Pikeminnow and Smallmouth Bass; see additional discussion below). Pools and riffles will also be inundated with inflation of the dam, further reducing habitat complexity.

The Sonoma Water Diversion Facility uses a variety of chemicals for its water transmission system. Herbicides are used to control vegetation along access roads, an anti-corrosion chemical is used in the transmission system piping, and chlorine is used to disinfect diverted water. Sonoma Water's implementation of BMPs for chemical storage and use, including storage of all such chemicals at least 250 feet from water, and de-chlorination prior to discharges, the risk of

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[542] NMFS, 2008. *Op. cit.*

[543] Barnhard, 1986. *Op. cit.*

[544] Bjorn and Reiser, 1991. *Op. cit.*

[545] Hassler, 1987. *Op. cit.*

these chemicals entering into salmonid habitat during normal operations is negligible. Accidental spills do have the potential to introduce chlorinated water to streams in the watershed. Sonoma Water has de-chlorination baskets and alerts on each of 17 valves that could result in a spill of chlorinated water via valve failure. In addition, chlorine storage buildings are equipped with leak detection alarm systems that alert Sonoma Water's operation and maintenance center. Additionally, scrubbers would be activated if chlorine gas is accidentally released.

6.8.1.2 Species Effects

Salmonids may become stranded when inflation and deflation of the inflatable dam change river stage levels at the site as described above. The rate of change in the river stage in these areas depends on the rate the dam is raised or lowered. Rapid changes can dewater habitat occupied by juvenile and adult salmonids. Mortality may result if fish become desiccated or suffocate when trapped in isolated pools. Trapped fish may be at a higher risk from predation. Vulnerability to stranding appears to be size dependent, with juvenile salmonids more vulnerable to stranding than adults. Importantly, the dam is deliberately inflated and deflated at a slow rate to avoid stranding. Salmonid stranding during dam inflation and deflation has not been documented by Sonoma Water staff.

Historically, flood flows that overtopped the infiltration ponds were likely to trap salmonids in the ponds when flows receded. During these events, Sonoma Water captured Chinook Salmon from the Mirabel infiltration ponds, and both Chinook Salmon and steelhead from the Wohler infiltration ponds. As floodwaters receded, fish stranded in these ponds would perish without intervention. However, following implementation of activities prescribed in the *2008 Biological Opinion*, the Wohler infiltration ponds were graded to drain naturally into the river. Thus, Sonoma Water no longer conducts fish rescue activities in these features (see Section 4.6.4.1, *Wohler Infiltration Ponds Decommissioning*).

The viewing chamber will likely flood every winter, and Sonoma Water anticipates rescuing stranded fish from within the viewing chamber multiple times per winter. Based upon past stranding at their Wohler Pond facility (an annual occurrence that has since been corrected), Sonoma Water expects that up to 15 juvenile salmonids may require capture and relocation back into the mainstem river. Sonoma Water will attempt to capture stranded fish via seine and will only utilize electrofishing to recover fish that remain after the seining efforts. These efforts will likely be required over the expected 50-year life of the ladder/screen structures.

There is always the potential for injury or mortality when relocating juvenile salmonids. Fish collecting gear, whether passive or active has some associated risk to fish, including stress, disease transmission, injury, or death. The amount of unintentional injury and mortality attributable to fish capture varies widely depending on the method used, the ambient conditions, and the expertise and experience of the field crew. Based on information from other relocation efforts, NMFS had previously estimated that injury and mortalities would be less than three percent of those steelhead, Coho Salmon and Chinook Salmon that are relocated and no more than 15 juvenile salmonids (of any combination) would be harassed through capture and relocation efforts per rescue operation.[546] With up to 3 rescue operations during the winter, it is anticipated no more than 45 juvenile salmonids will be rescued in total per year. Furthermore, given an expected mortality rate no greater than 3%, no more than 2 juvenile salmonids will be killed as part of annual rescue operations in the viewing chamber. No fish are expected to avoid capture and thus be harmed when the chamber is fully dewatered, since no cover or hiding areas exist within the chamber. Recently spawned adult steelhead kelts may enter the facility and require rescue/relocation, but the likelihood of this happening is low given a kelt's presumed preference for migrating downstream within the deeper, thalweg area of the channel (conversely, juvenile salmonids likely favor shallow habitat along the riverbank, where cover from predators and food availability is greatest). Thus, it is anticipated that no more than 1 steelhead kelt will require capture and relocation from the viewing chamber on an annual basis.

NMFS and CDFW have expressed concern regarding the status of both native and nonnative predatory fish and associated effects of predation on outmigrating juvenile salmonids, with a particular interest on Wohler Pool. Two species of particular interest are Pikeminnow and Smallmouth Bass. Pikeminnow are native to the Russian River and occupy pools throughout the Russian River and the lower reaches of the larger tributaries. Smallmouth Bass are native to the eastern half of the United States and southern Canada[547] and are widespread throughout the mainstem Russian River. The status, life-history, and distribution of these species are discussed in detail in Section 4.9.1.

As described in Section 4.9.4, Sonoma Water began conducting studies to characterize the fish community and habitat conditions in Wohler Pool of the lower Russian River in 1999.[548,549,550] Since that time, additional monitoring has continued for various purposes using different methods (total period of monitoring runs from 1999 to 2019). For purposes of boat electrofishing, the Wohler Pool study area was divided into five reaches (Figure 4-31). Reach #1 was located adjacent to Steelhead Beach Regional Park, which is located approximately 2.4 km downstream of the Inflatable Dam. Reach #2 was located in the lower third of the Wohler Pool and Reach #3 was located in the middle third of the Wohler Pool. As discussed above, habitat in Reaches 2 and 3 is significantly altered by the Inflatable Dam. Reach #4 occupies the upper 1.6 km of the Wohler Pool, and is minimally affected by the dam, with the influence of the dam declining to virtually zero at the upstream end. Reach #5 is above the influence of the impoundment, and consists of natural pools, runs and riffles.

All five reaches provide suitable habitat conditions for the two predatory species (see Table 4-35). Based on a review of habitat requirements for Smallmouth Bass and catch data, reaches 1 (below the dam and pool), 2, and 3 appear to provide the most suitable habitat. Stream gradient in the Russian River declines below the dam, and there is a higher frequency of pool type habitats

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[546] NMFS, 2014. Mirabel Fish Screen/Ladder Project Biological Opinion. USACE and Sonoma County Water Agency. WCR-2013-9815. June 16, 2014.

[547] Moyle, P.B. 2002. *Op. cit.*

[548] Chase et al. 2005. *Op cit.*

[549] Cook 2003. *Op cit.*

[550] Sonoma Water, unpublished data. *Op cit.*

compared to the above dam habitat.[551] The greater depth and lower current velocity associated with pool habitats is preferred by centrarchids (which include Smallmouth Bass).

Based on sampling, it appears that Smallmouth Bass dominates the predatory fish population in these reaches with the largest catch occurring in Reach #1, which is downstream of Mirabel Dam. However, the majority of Smallmouth Bass captured in all reaches were young-of-the-year (see Table 4-36). Similarly, Pikeminnow catch was dominated by fish that were age 0+ and 1+, based on size class (<250 mm), which are not likely sufficient size to prey on Chinook Salmon (Table 4-36). It is not known if the relatively low number of older Smallmouth Bass and Pikeminnow is due to a high rate of mortality, or a high rate of dispersal by young fish to areas outside of the area. Winter habitat conditions (i.e., when the dam is deflated) may at least partially explain the poor recruitment to older age classes. Smallmouth Bass and Pikeminnow attain a size sufficient to prey on Chinook Salmon by the start of their third year of life (age 2+).

In 2021 and 2022, Sonoma Water conducted two survival studies focused on Coho Salmon smolts. The goal of these studies was to provide information on the efficacy of recovery strategies based on releases of hatchery-reared Coho Salmon smolts. The primary study objective was to estimate Coho Salmon smolt survival from Dry Creek through the mainstem Russian River and Estuary – the “migration corridor.” A secondary objective was to evaluate methods for characterizing sources of mortality.

Survival estimates were developed for the entire study area (all reach breaks) by release group (date) (Figure 4-33) and by river segment (Dry Creek, Russian River mainstem, Estuary) (Figure 4-34). Summary findings from these studies identify the following:

- Trends in survival were identified by release group with survival decreasing from first to last release. These trends appear to be associated with relationships between survival and flow and turbidity. The analysis found positive relationships between higher survival and higher flow, and higher survival and higher turbidity.

- Dry Creek and the Estuary were identified as segments with higher survival compared to the mainstem Russian River. Marked decreases in survival were identified for the reach at the Dry Creek mouth (from the mouth to Syar ponds) and at the Mirabel Dam. Changes in water temperature transitioning between Dry Creek and the mainstem Russian River may be a factor in in this reach.

Additional research is needed to better understand the mechanisms associated with losses at the mouth of Dry Creek, where it enters the mainstem Russian River, and potential mechanisms associated with Mirabel Dam losses.

An additional area of concern for salmonid loss in Wohler Pool is avian predators. While no studies or targeted monitoring efforts have been conducted to assess or quantify this concern, several avian predators, including mergansers, have been observed in the pool and in the vicinity

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[551] Chase et al. 2005. *Op cit.*

of the dam. Salyer and Lagler (1940)[552] estimated from observations and stomach samples that an adult merganser would consume from one to one and one-half pounds of fish daily or "one-third to one-half its body weight. Further, monitoring on the Yakima River Basin identified avian predation on fish as a substantial contribution to the loss of migrating juvenile salmonids. Specifically, the monitoring estimated that fish consumption by common mergansers ranged from 6893 kilograms of fish consumed in the spring to 4310 kilograms of fish in the summer in the upper river.

In order to address uncertainties associated with Coho Salmon smolt survival, with a particular interest on loss, including that associated with predation, Sonoma Water propose the following conservation measure (see Section 3.10, *Conservation Measures*).

> **Conservation Measure (CM5):** Undertake special studies to better understand loss rates of outmigrating salmonids and, if necessary, implement measures to ensure that harm and mortality to listed salmonids are low.
>
> Sonoma Water and USACE will develop and implement special studies to better understand loss rates of outmigrating salmonids and, if necessary, implement measures to ensure that harm and mortality to listed salmonids are low.
>
> - The study objective is to estimate salmonid survival from Dry Creek through the mainstem Russian River and Estuary – the “migration corridor” and to evaluate methods for characterizing sources of mortality with a focus on identifying effects associated with facility operations. Special emphasis will be placed on addressing uncertainties associated with areas with higher loss rates identified from previous studies (e.g., confluence of Dry Creek and Russian River, Syar ponds, Mirabel Dam and Wohler Pool) and species of management concern (e.g., listed salmonids, native and nonnative predatory fishes, avian predators).
> - A study plan will be developed in coordination with NMFS and CDFW within one year of the issuance of the new BO and ITP. The study plan will include schedules for field implementation and reporting.
> - Study methodologies may include the use of acoustic telemetry, predation detection transmitters, boat electrofishing, predation event recorders, avian predator surveys, and other techniques.
> - If sources of mortality concern are attributed to Sonoma Water and/or USACE facility operations, Sonoma Water will implement contingency measures to ensure that harm and mortality to listed salmonids are minimized.

While uncertainties exist regarding adverse effects associated with operation of Mirabel Dam and Wohler Pool, the conservation measure will ensure that special studies are being implemented to better understand loss rates of outmigrating salmonids and, if necessary, measures to ensure that harm and mortality to listed salmonids are low will be implemented.

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[552] Monitoring and Evaluation of Avian Predation on Juvenile Salmonids on the Yakima River, Washington Annual Report 2004.

6.8.2 Wastewater Treatment

Project operations for purposes of water supply result in the diversion of water from the Russian River, a substantial portion of this water supply is consumed, eliminated as waste, treated as wastewater, and ultimately recycled or discharged back into the Russian River watershed as treated effluent.

6.8.2.1 Habitat and Species Effects

Wastewater discharges in the Russian River watershed are controlled and scheduled under the established policies of the Water Quality Control Plan for the North Coast Region. Water treated to a tertiary level or better is discharged back into Jones Creek, Dutch Bill Creek, Mark West Creek, and the Laguna de Santa Rosa tributaries of the Russian River. Wastewater facilities are permitted to discharge to tributaries of the Russian River between May 15 and October 1; some commence discharges beginning in November, some end discharges April 30. Under the permits issued by the NCRWQCB, treatment plants can only discharge at 1 percent of the receiving water flow rate, except the Santa Rosa Subregional Wastewater Reclamation System (SRSWRS), which has a discharge allowance of 5 percent of ambient flow. Overall, wastewater discharges in the Russian River watershed are expected to have a negligible effect on salmonids and salmonid instream habitat. The potential effects on habitats and species associated with operations of wastewater treatment facilities is similar to those occurring under the baseline.

6.9 Cumulative Effects

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Federal ESA requires USFWS and NMFS to evaluate the cumulative effects of the Proposed Action on listed species and designated critical habitat, and to consider cumulative effects in formulating biological opinions (USFWS and NMFS 1998). Future Federal actions unrelated to the Proposed Action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Federal actions, including activities that would require a permit under CWA Section 404 (Federal action), are, therefore, not included.

NMFS staff maintain regular contact with local State agency staff, local governments and private individuals and organizations within the action area. For example, NMFS staff have been meeting with private property owners to develop habitat improvement plans for some areas of the Russian River watershed. These projects will likely require separate section 7 consultation because they would require CWA Section 404 permits. Other than the impacts of past, present, and ongoing actions such as agriculture, forestry, and urbanization that have been described in the Environmental Baseline, additional cumulative effects are reasonably certain to occur in the action area during the period of this consultation. It is expected that the impacts of the ongoing actions during the period of this consultation to be similar to the present-day impacts on listed salmonids and their critical habitat identified in the Environmental Baseline.

SECTION 7

Conclusions and Determinations

This section integrates project effects by species and life-history stage to evaluate the overall effect on populations of each species and their designated critical habitat. To integrate and assess effects of the Proposed Action, the timing and locations of operational activities are correlated with temporal and spatial characteristics of listed fish populations, including life-history strategy, habitat use, and geographical distribution. The following discussion tracks each species through their life-history in the Russian River watershed to determine the interactions with the Proposed Action and identify the potential collective effects. The effects of the individual actions were described in Section 6. This analysis focuses on the most important potential project effects, both adverse and beneficial, to provide perspective on how the proposed project will affect the ability of the Coho Salmon, steelhead, Chinook Salmon, and Longfin Smelt to complete their lifecycles and contribute to future generations.

Chinook Salmon use the upper and middle mainstem Russian River and Dry Creek for migration, spawning, and rearing, while Coho Salmon use the mainstem largely as a migration corridor. Coho Salmon rely on tributaries for spawning and rearing. Steelhead use both the mainstem Russian River and tributary habitat for spawning and rearing. All three species can potentially use Dry Creek for spawning and rearing. Longfin Smelt would only use the Estuary.

This analysis focuses on identifying the effects of the Proposed Action on upstream migration, spawning/incubation, rearing, and emigration of the listed species. Limiting factors are identified, where known, so that effects, both adverse and beneficial, can be identified. Effects are integrated over all life-history stages to determine the overall effect of the Proposed Action on salmonids and their habitat.

Project effects are classified into one of three categories:

- Adverse effects that were identified under baseline operations, but which are reduced to minimal or no effect under the Proposed Action.
- Effects that may adversely affect salmonids or their habitat.
- Beneficial effects.

In each case, effects of the Proposed Action are evaluated for their overall effect on Coho Salmon, steelhead, and Chinook Salmon and their designated critical habitat, and Longfin Smelt.

7.1 Coho Salmon

Coho Salmon have a fixed 3-year lifecycle. Peak adult upstream migration generally occurs November through February. Spawning takes place from December to mid-February, and eggs can incubate as late as the end of March. Fry begin to emerge as early as February and as late as the first part of April, and juveniles spend approximately one year in freshwater tributaries before becoming smolts. Smolt emigration usually occurs between February and mid-May.

Coho Salmon primarily use tributaries to the lower Russian River and Dry Creek for spawning and rearing and use the mainstem for migration. Many of the tributaries that currently support Coho Salmon are downstream of the water diversion operations at Mirabel. These habitat-use patterns tend to separate Coho Salmon from some project operations. In some cases, potential project effects are low because Coho Salmon abundance is low, and their distribution is limited.

An important limiting factor for Coho Salmon is rearing habitat. Survival during the rearing period is affected by such factors as water quality, flow rates, and habitat quality. There are several activities associated with the Proposed Action that should help improve rearing habitat in streams already occupied by Coho Salmon and in streams that could potentially support Coho Salmon populations in the future.

The Proposed Action has little opportunity to negatively affect returning adults, as current populations are primarily limited to a few tributaries. However, to reduce the chance of extirpation from the Russian River, Coho Salmon populations must eventually occupy a much greater number of tributaries in the basin. Thus, any project activities that improve conditions for upstream and downstream migration could play an important role in the recovery of viable Coho Salmon populations in the Russian River.

7.1.1 Effects of the Proposed Action on Coho Salmon

In this section, effects of the Proposed Action are integrated by life-history stage for Coho Salmon. In general, implementation of activities is likely to result in relatively small adverse effects, and often constitute an improvement relative to current operations. A few ongoing activities, however, could adversely affect Coho Salmon, particularly downstream migration.

7.1.1.1 Adult Upstream Migration

In the lower Russian River and Dry Creek, proposed instream flows would continue to provide suitable conditions for upstream migration. Under the Proposed Action, minimum instream flows will continue to provide suitable passage conditions for adult Coho Salmon. As discussed in Section 6.2, the interim petitions will prioritize lower releases in order to reduce the effects of high-water velocities. These changes will be mostly beneficial to Coho Salmon but could have small effects on the adult upstream passage condition. Temperature during the migration period is predicted to be suitable for adult migration and will be unaffected during November and December. The interim petitions would improve conditions for upstream migration in Dry Creek relative to the baseline condition, which may improve Coho Salmon access to tributaries for spawning.

Channel maintenance activities may result in short-term adverse effects during construction; however, these effects would be avoided and/or minimized through the implementation of BMPs. Over the long-term, habitat conditions would improve as a result of reduced erosion and sediment release exposure and restored native riparian communities.

Habitat enhancement in Dry Creek would benefit fish passage. Instream enhancement structures in Dry Creek may slightly enhance passage to Dry Creek tributaries by providing increased cover from predators and creating pools to provide refuge for migrating adults during high flows. This may help offset potential negative effects due to channel maintenance activities in this portion of the watershed. Thus overall, conditions for upstream migration are expected to be highly suitable and likely to improve in these streams relative to baseline conditions.

Mirabel/Wohler diversion facility operation and maintenance activities in the mainstem could affect Coho Salmon, although prior improvements to the operations of these facilities should reduce the risk of entrapment. These potential effects would be similar to those under baseline.

7.1.1.2 Spawning and Egg Incubation

Spawning and incubation habitat is less limiting for Coho Salmon in the Russian River than rearing habitat. Currently, spawning and incubation occur primarily in tributaries to Dry Creek and the lower mainstem Russian River, which are unlikely to be adversely affected by project activities. The Proposed Action should provide suitable habitat conditions for Coho Salmon during spawning and incubation during most periods. Activities that are expected to improve habitat conditions include reductions in minimum instream flows under the interim petitions (Proposed Action), and instream habitat enhancement proposed for Dry Creek.

Interim petitions and preliminary proposed Fish Flow Project would provide suitable spawning conditions for Coho Salmon in Dry Creek relative to water operations under Decision 1610. This is especially true in upper Dry Creek, where daily flows are predicted to provide a high frequency of suitable spawning and incubation flows.

Flood control operations, including application of FIRO, at WSD would continue similar to that under baseline and any potential effects associated with these operations (scour and bank erosion) would also be expected to be similar. These adverse effects are expected to be relatively small.

Instream habitat enhancement planned for Dry Creek would improve spawning and incubation conditions for Coho Salmon. These actions would increase the extent of riffle and pool tail-out habitat that may serve as future spawning areas for Coho Salmon in the mainstem. Instream habitat structures, such as large woody debris, would also help reduce the chance of redd scour during storm events, thereby increasing the overall egg-to-fry survival rate.

7.1.1.3 Juvenile Rearing

Because Coho Salmon rear year-round, summer-rearing habitat is thought to be an important limiting factor for Russian River Coho Salmon. All Coho Salmon rearing habitat is currently located in tributaries in the lower Russian River (e.g., Green Valley Creek and Maacama Creek) and Dry Creek. There are multiple activities that would improve summer rearing conditions for juvenile Coho Salmon. These activities include revisions to instream flows under interim petitions and preliminary proposed Fish Flow Project, which would provide suitable habitat conditions for this species, and habitat enhancement projects within Dry Creek. The Proposed Action, including interim petitions and preliminary proposed Fish Flow Project, include reductions in minimum instream flows are expected to benefit Coho Salmon summer rearing conditions in Dry Creek.

Effects on juvenile rearing associated with channel maintenance activities would be similar to those described above for adult upstream migration. These potential effects would be small and similar to those under baseline.

Passive operation of the Santa Rosa Creek Diversion Structure would not be expected to result in the entrainment and diversion of juvenile Coho Salmon because Coho Salmon are not expected to occur in this part of the watershed.

Juvenile rearing habitat has been improving in Dry Creek and its tributaries since publication of the *2008 Biological Opinion* due to the implementation of substantial habitat enhancement. The additional habitat enhancement projects planned would continue to improve localized habitat complexity and benefit young Coho Salmon through the creation of scour, plunge, and backwater pools. Pool habitat is essential for juvenile survival because it provides a refuge for high flows, cover from predators, and suitable rearing temperatures.

Construction of Dry Creek enhancements would be expected to result in temporary, adverse effects; however, these effects would be avoided and/or minimized with the implementation of BMPs, similar to implementation of past Dry Creek enhancements.

Under the Proposed Action, the Estuary would continue to be managed to minimize artificial breaching at the mouth of the Russian River. This may provide some benefit to juvenile fish, however, the potential for the Estuary to support the extended rearing of Coho Salmon is limited.

7.1.1.4 Juvenile Downstream Migration

The Proposed Action would be expected to result in largely negligible effects on the downstream migration of smolts; however, some potential risks remain for young Coho Salmon as they migrate downstream.

Effects on juvenile downstream migration associated with channel maintenance activities would be similar to those described above for adult upstream migration. These potential effects would be small and similar to those under baseline.

There would be no effect on juvenile downstream migration associated with passive operation of the Santa Rosa Creek Diversion Structure since Coho Salmon are not present within this portion of the watershed.

Mirabel/Wohler diversion facility operation and maintenance activities in the mainstem could affect Coho Salmon, although prior improvements to the operations of these facilities should reduce the risk of entrapment. During the first 8 hours after the inflatable dam is raised, there is a small risk of stranding smolts or exposing them to avian predation as flows are reduced in the reach just downstream of the dam. Smolts could still be delayed at the inflatable dam if they have difficulty locating the augmented flow channel through the new fish ladder. They could also fall prey to predatory fish in Wohler Pool or in Wohler infiltration ponds. While uncertainties exist regarding adverse effects associated with operation of Mirabel Dam and Wohler Pool and associated predation risks, the proposed conservation measure will ensure that special studies are being implemented to better understand loss rates of outmigrating salmonids and, if necessary, measures to ensure that harm and mortality to listed salmonids are low will be implemented.

7.1.2 Coho Salmon Response to the Proposed Action

Beneficial effects of the Proposed Action are summarized in **Table 7-1**. Overall, the Proposed Action would be expected to improve habitat for Coho Salmon and should play an important role in the recovery of Coho Salmon populations in the Russian River. However, there are a few ongoing activities that could result in adverse effects (**Table 7-2**).

TABLE 7-1
POTENTIAL BENEFICIAL EFFECTS TO COHO SALMON

Life-History Stage	Beneficial Effects of the Proposed Action
Adult Upstream Migration	Implementation of interim petitions in Dry Creek
	Instream enhancement projects in Dry Creek that increase cover and high-flow velocity refuge
Spawning and Incubation	Instream enhancement structures in Dry Creek to maintain riffle and pool tail-out habitats and spawning gravels
Juvenile Rearing	Implementation of interim petitions in Dry Creek
	Instream enhancement projects in Dry Creek
	Small benefit from instream enhancement projects in the Estuary
Juvenile Downstream Migration	Implementation of interim petitions in Dry Creek and Russian River

TABLE 7-2
POTENTIAL ADVERSE EFFECTS ON COHO SALMON

Life-History Stage	Adverse Effects of the Proposed Action
Juvenile Rearing	Temporary, construction-related effects associated with channel maintenance activities (avoided and/or minimized)
	Temporary, construction-related effects in Dry Creek (avoided and/or minimized)
Juvenile Downstream Migration	Temporary, construction-related effects associated with channel maintenance activities (avoided and/or minimized)
	Stranding during inflation of Mirabel Dam
	Predation in Wohler Pool or infiltration ponds

7.1.2.1 Integration of Project Effects on Coho Salmon Habitat

Integration of the overall effects of the Proposed Action activities indicates that overall habitat conditions for Coho Salmon would be managed in a suitable condition and be an improvement relative to current conditions. Dry Creek habitat enhancements would affect all stages of the freshwater Coho Salmon lifecycle in Dry Creek in a beneficial manner and should help facilitate their recovery.

Project activities that are most likely to improve habitat suitability conditions for Coho Salmon are the Dry Creek enhancements and interim petitions and preliminary proposed Fish Flow Project. These Proposed Action elements would provide suitable habitat conditions through physical enhancements and through improved flow-habitat relationships associated with operations by reducing velocities with reductions in minimum instream flows. This could have a positive effect on population growth rates because summer and over-wintering habitat are typically considered limiting factors for Coho Salmon in the Russian River.

Instream enhancement actions are most likely to have the most immediate beneficial effect on Coho Salmon abundance in Dry Creek. These actions include placing large woody debris or other instream structures in to create more pool habitat where juveniles can rear. Additional actions include planting riparian vegetation to provide protective cover from predators, reduce water temperatures, and provide additional habitat for invertebrates. The quality of spawning habitat would also improve as a result of instream enhancement actions. USACE would add instream structures at suitable locations in Dry Creek to increase habitat complexity and to capture and hold Coho Salmon spawning gravels. This should increase the amount of riffle habitat and help reduce redd scour.

Construction of Dry Creek enhancements would be expected to result in temporary, adverse effects; however, these effects would be avoided and/or minimized with the implementation of BMPs, similar to past Dry Creek enhancements.

Flood control operations at WSD would continue similar to that under baseline and any potential effects associated with these operations (scour and bank erosion) would be expected to be small.

Implementation of interim petitions and preliminary proposed Fish Flow Project in Dry Creek would improve rearing conditions and could help facilitate the recovery of viable Coho Salmon populations in Dry Creek and its tributaries. These operations would also provide suitable conditions for spawning and upstream migration, increasing the probability that abundances in this region would increase in the future.

Although activities are expected to improve downstream migration relative to baseline conditions, there would still be potential ongoing negative effects that could impede smolt migration. For example, risks to juveniles during downstream migration include temporary, construction-related effects associated with channel maintenance activities (avoided and/or minimized), and an increased risk of predation for fish in Wohler Pool. While uncertainties exist regarding adverse effects associated with operation of Mirabel Dam and Wohler Pool and associated predation risks, the proposed conservation measure will ensure that special studies are being implemented to better understand loss rates of outmigrating salmonids and, if necessary, measures to ensure that harm and mortality to listed salmonids are low will be implemented.

Given the overall improvements to instream habitat through enhancement actions and operations with the interim petitions and preliminary proposed Fish Flow Project, any adverse effects would be relatively small. Due to the combined improvements in habitat conditions in Dry Creek and the interim petitions and Fish Flow Project the distribution and abundance of Coho Salmon in the Russian River would be expected to increase under the Proposed Action.

7.1.3 Determinations for Coho Salmon

7.1.3.1 Federal Endangered Species Act

Given the current status of CCC Coho Salmon ESU, the current environmental baseline for the Proposed Action, and the effects of the Proposed Action, it is concluded that the Proposed Action would adversely affect Coho Salmon and their designated critical habitat. Adverse effects associated with the Proposed Action have been avoided and/or minimized and would be expected to be small and would not jeopardize the species' continued existence or preclude recovery of these species.

7.1.3.2 California Endangered Species Act

Given the current status of Coho Salmon, the current environmental baseline for the Proposed Action, and the impacts of the Proposed Action, it is concluded that implementation of the Proposed Action could result in take of this species under CESA. Take of the species associated with the impacts of the Proposed Action, would be expected to be very small and would not jeopardize the species' continued existence, or preclude recovery of these species. Sonoma Water is seeking an Incidental Take Permit for Coho Salmon pursuant to Fish and Game Code section 2081.

7.2 Steelhead

Unlike Coho Salmon, steelhead do not have a fixed 3-year lifecycle. They typically spend 2 years in the ocean before returning to spawn and may return to the ocean after spawning to spawn again in a later year. Peak adult upstream migration occurs from January through March.

Steelhead usually spend 1 or 2 years rearing in freshwater but can remain for longer periods of time before migrating to the ocean. Steelhead rear year-round in the tributaries and throughout the middle and upper mainstem. Their distribution is widespread in the Russian River watershed, including Dry Creek and its tributaries. While some juveniles rear in the lower mainstem before smolt outmigration, summer water temperatures in much of this region are too warm to provide suitable conditions for juveniles in most years. Tributaries in the lower reaches tend to provide less vegetative cover, are often wide and shallow, and have little riparian vegetation. Water temperatures in the mainstem near the coast are cooler, and the Estuary provides year-round rearing habitat.

Because steelhead use so much of the Russian River watershed, the Proposed Action has the opportunity to affect all life stages and their habitat; however, the greatest effect would likely occur during juvenile rearing. Some of the most important project effects are related to summer rearing habitat in the upper Russian River, Dry Creek, and the Estuary, which can be influenced by water management, including operations at the dams.

Several activities would result in improved conditions for steelhead. For instance, implementation of the interim petitions, preliminary proposed Fish Flow Project, petitions and application of FIRO procedures at CVD are expected to result in conservation of the cold water pool in Lake Mendocino, which would improve water temperatures in the upper Russian River during summer and fall. The interim petitions and preliminary proposed Fish Flow Project would benefit summer rearing habitat in the upper Russian River through reductions in water velocities with modifications to minimum instream flows. Enhancement actions in Dry Creek would have benefits for spawning and rearing habitat that could help to offset project effects from activities such as channel maintenance. Together, these activities could provide an increase in steelhead production and survival during the freshwater period.

Maintenance activities in the mainstem, passive operations of the Santa Rosa Creek Diversion Structure, and Mirabel/Wohler diversion facility operation could adversely affect steelhead, although these effects would be avoided and/or minimized and would be small.

7.2.1 Effects of the Proposed Action on Steelhead

In this section, potential effects are integrated by life-history stage. Implementation of several activities would likely either reduce adverse effects relative to baseline conditions or provide potential benefits. However, some ongoing activities could still adversely affect steelhead and their critical habitat, particularly juvenile rearing and downstream migration.

7.2.1.1 Adult Upstream Migration

The Proposed Action will continue to provide suitable upstream passage conditions for adult steelhead. The interim petitions and preliminary proposed Fish Flow Project will result in reduced minimum instream releases due to changes in PVP inflows which will likely result in drier conditions. This may result in enhancements to steelhead fry and juvenile rearing habitat; however, this may come at the cost of small effects on upstream passage during the early portions of the migration window.

Effects on adult steelhead migration associated with channel maintenance activities would be similar to those described above for Coho Salmon and would result in negligible effects to adult migration.

Instream enhancement in Dry Creek may slightly improve passage to Dry Creek tributaries by providing increased cover from predators and creating pools to provide refuge for migrating adults during high flows. This may help offset potential negative effects due to channel maintenance activities in this portion of the watershed. Thus, the overall effect of the Proposed Action on the upstream migration of steelhead is expected to be negligible

Mirabel/Wohler diversion facility operation and maintenance activities in the mainstem could affect steelhead, although prior improvements to the operations of these facilities should reduce the risk of entrapment.

7.2.1.2 Spawning and Egg Incubation

The Proposed Action would result in similar conditions required by steelhead for spawning in the upper Russian River compared to baseline. Flood control operations at CVD would be similar to that under baseline and any potential adverse effects associated with these operations (e.g., scour and bank erosion) would also be expected to be negligible. Flood control operations at WSD would continue as under baseline and any potential adverse effects associated with these operations (scour and bank erosion) would also be expected to be negligible.

The Proposed Action would provide similar spawning conditions for steelhead in Dry Creek and the Russian River relative to water management practices under the baseline.

Instream habitat enhancement planned for Dry Creek would also improve spawning and incubation conditions for steelhead. These actions would increase the extent of riffle and pool tail-out habitat that may serve as future spawning areas for steelhead in the mainstem. Instream habitat structures, such as large woody debris, would also help reduce the chance of redd scour during storm events, thereby increasing the overall egg-to-fry survival rate.

Flood control operations at WSD would continue similar to that under baseline and any potential adverse effects associated with these operations (scour and bank erosion) would be expected to be negligible.

7.2.1.3 Juvenile Rearing

As juveniles rear year-round in freshwater streams, the amount of summer rearing habitat is an important limiting factor affecting the recovery of Russian River steelhead. Continued implementation of the Deviation and application of FIRO procedures at CVD are expected to result in conservation of cold-water pool in Lake Mendocino, which would improve water temperatures in the upper Russian River relative conditions prior to implementing these procedures. Other flood control operational effects in the upper Russian River (ramping) under the Proposed Action would be similar or be considered a small benefit compared to baseline.

Turbidity releases in the spring and summer would be most likely to adversely affect rearing juvenile steelhead in the Russian River mainstem. Elevated turbidity could reduce visibility and impair feeding or the ability to detect predators. Increased energy expenditures would be required if it is necessary to clear sediment from the gills through “flaring,” etc. Juveniles closer to CVD would be expected to incur the greatest impacts because the turbidity dissipates moving downstream. USACE has begun exploring options to reduce the turbidity within Lake Mendocino and downstream and will continue to meet with the TAC to develop and implement short-term minimization measures.

Implementation of the Proposed Action is not expected to adversely affect steelhead summer rearing conditions in Dry Creek. The small changes in instream flows under these petitions are expected to improve the quantity and quality of rearing habitat for steelhead in Dry Creek. Reductions in minimum instream flows under the Proposed Action would increase the amount of rearing habitat available for steelhead fry in the upper Russian River.

Effects on juvenile rearing associated with channel maintenance activities would be similar to those described above for adult upstream migration and under the baseline and would have a negligible effect on juvenile rearing.

Passive operation of the Santa Rosa Creek Diversion Structure could result in the entrainment and diversion of juvenile steelhead; however, risk would be low because timing of passive operations would not be expected to occur during outmigration periods, and the frequency of storms that would activate the diversion structure is low.

Juvenile rearing habitat has also been improving in Dry Creek and its tributaries due to the implementation of habitat enhancements. The additional habitat enhancement planned for this region would continue to improve localized habitat complexity and benefit young steelhead through the creation of scour, plunge, and backwater pools. Pool habitat is essential for juvenile survival because it provides a refuge for high flows, cover from predators, and suitable rearing temperatures.

Construction of Dry Creek enhancements would be expected to result in temporary, adverse effects; however, these effects would be avoided and/or minimized with the implementation of BMPs, similar to implementation of past Dry Creek enhancements.

Under the Proposed Action, the Estuary would continue to be managed to minimize artificial breaching at the mouth of the Russian River. Research and monitoring conducted throughout the term of the *2008 Biological Opinion* has demonstrated that baseline conditions support steelhead use of the Estuary; provide abundant invertebrate prey, and promote optimal growth conditions in portions of the Estuary. The Proposed Action seeks to improve rearing conditions by considering opportunities to enhance habitat.

7.2.1.4 Juvenile Downstream Migration

The Proposed Action would be expected to result in negligible effects on the downstream migration of smolts relative to baseline operations, however, some risk does remain for young steelhead as they migrate downstream.

There is expected to be a negligible change to a slight improvement in juvenile downstream migration flows from implementation of the Proposed Action in the upper Russian River (implementation of the Deviation with application of FIRO procedures and interim petitions). Compared to baseline, outmigrant flows in the lower Russian River also remain relatively similar for the Proposed Action. Therefore, implementation of the Proposed Action would not substantially interfere with the movement or migration of steelhead in the upper or lower Russian River and effects would be similar to those under baseline.

Effects on juvenile downstream migration associated with channel maintenance activities would be similar to those described above for adult upstream migration and under the baseline and would not result in adverse effects on migrants.

Effects on juvenile downstream migration associated with passive operation of the Santa Rosa Creek Diversion Structure would be similar to those described above for juvenile rearing and under the baseline and would pose limited risk of entrainment.

Mirabel/Wohler diversion facility operation and maintenance activities in the mainstem could affect steelhead, although prior improvements to the operations of these facilities should reduce the risk of entrapment. During the first 8 hours after the inflatable dam is raised, there is a small risk of stranding smolts or exposing them to avian predation as flows are reduced in the reach just downstream of the dam. Smolts could still be delayed at the inflatable dam if they have difficulty locating the augmented flow channel through the new fish ladder. While uncertainties exist regarding adverse effects associated with operation of Mirabel Dam and Wohler Pool and associated predation risks, the proposed conservation measure assessing Coho Salmon survival will inform potential issues for steelhead and ensure that special studies are being implemented to better understand loss rates of outmigrating salmonids and, if necessary, measures to ensure that harm and mortality to listed salmonids are low will be implemented.

7.2.2 Steelhead Response to the Proposed Action

Beneficial effects of the Proposed Action are summarized in **Table 7-3**. Overall, the Proposed Action would be expected to improve habitat for steelhead and should play an important role in the recovery of steelhead populations in the Russian River. However, there are a few ongoing activities that could result in adverse effects (**Table 7-4**).

TABLE 7-3
POTENTIAL BENEFICIAL EFFECTS TO STEELHEAD

Life-History Stage	Beneficial Effects of the Proposed Action
Adult Upstream Migration	Implementation of interim petitions
	Instream enhancement projects in Dry Creek that increase cover and high-flow velocity refuge
Spawning and Incubation	Instream enhancement structures in Dry Creek to maintain riffle and pool tail-out habitats and maintains spawning gravels
Juvenile Rearing	Continued implementation of Deviation with application of FIRO procedures (at CVD) in combination with the interim petitions
	Instream enhancement projects in Dry Creek
	Instream enhancement projects in the Estuary
Juvenile Downstream Migration	Implementation of interim petitions in Dry Creek and Russian River

TABLE 7-4
POTENTIAL ADVERSE EFFECTS ON STEELHEAD

Life-History Stage	Adverse Effects of the Proposed Action
Juvenile Rearing	Temporary, construction-related effects associated with channel maintenance activities (avoided and/or minimized)
	Temporary, construction-related effects in Dry Creek (avoided and/or minimized)
	Turbidity effects from CVD releases
Juvenile Downstream Migration	Temporary, construction-related effects associated with channel maintenance activities (avoided and/or minimized)
	Potential for entrainment associated with passive operations at Santa Rosa Creek Diversion Structure
	Stranding during inflation of Mirabel Dam
	Predation in Wohler Pool

7.2.2.1 Integration of Project Effects on Steelhead Habitat

Of the three listed salmonid species in the Russian River system, steelhead are the most widespread and abundant. As a result, steelhead may be influenced by the full range of effects produced through the Proposed Action. Steelhead also have a protracted freshwater rearing phase lasting up to two years or more and, unlike Coho Salmon and Chinook Salmon, do not have a relatively fixed three-year lifecycle. This means that juveniles will be influenced by activities in the river and the watershed for much longer; hence, activities can affect all life stages and the habitats associated with them.

Overall, under the Proposed Action, the conditions in the Russian River system would likely be beneficial to the continued survival of steelhead in the river system, and stocks would likely improve compared to baseline conditions. There would be relatively few direct adverse effects on steelhead mortality associated with the Proposed Action, and the few effects that could occur would likely be small and localized. Most of the effects on steelhead would arise as a result of project activities on habitat conditions, which in turn could influence the various life stages.

The primary effect of the interim petitions and preliminary proposed Fish Flow Project in the Russian River would be to improve steelhead summer rearing habitat by reducing summer flows relative to Decision 1610. This is especially true in the area between Cloverdale and the Forks, which provides the best steelhead rearing habitat in the mainstem. Reduced flows in Dry Creek would provide a benefit to rearing steelhead during the summer months relative to management under Decision 1610. In general, the improved rearing flows throughout the Russian River basin could result in a marked increase in juvenile survival. This increase in survival should translate into future increases in adult abundance and a reduced risk of population decline.

Continued implementation of the Deviation and application of FIRO procedures, and interim petitions and preliminary proposed Fish Flows Project at CVD are expected to result in conservation of cold water pool in Lake Mendocino, which would improve water temperatures in the upper Russian River relative to prior operating conditions.

There is the potential for considerable positive effects on steelhead spawning and rearing from the habitat enhancements being carried out in Dry Creek, and which will continue as part of the Proposed Action. Stream habitat improvement is now an established and proven discipline in river management programs, and has been shown to alleviate, restore, and mitigate the adverse changes produced through land and water resource development projects).[553] Habitat improvement programs can both revitalize natural river features, such as the pool-riffle pattern, and lead to an overall increase in habitat diversity, which is an essential habitat requirement in the population ecology of listed salmonids. The clear and direct correlation between the level of instream habitat diversity and levels of stream fish abundance are well documented in the scientific literature. Habitat enhancements in Dry Creek would continue to improve habitat and help counteract any possible detrimental effects of other operations and maintenance activities. Future enhancement actions in the Estuary would provide substantial benefits to rearing steelhead.

Construction of Dry Creek enhancements would be expected to result in temporary, adverse effects; however, these effects would be avoided and/or minimized with the implementation of BMPs, similar to past Dry Creek enhancements.

Although activities are expected to improve downstream migration relative to baseline conditions, there would still be potential ongoing negative effects that could impede smolt migration. For example, risks to juveniles during downstream migration include temporary, construction-related effects associated with channel maintenance activities (avoided and/or minimized), potential for entrainment associated with passive operations at Santa Rosa Creek Diversion Structure, entrainment and stranding during the inflation of the Mirabel Dam and an increased risk of predation in Wohler Pool. Given the overall benefits of the Proposed Action for steelhead, any loss of individuals due to these activities would be offset by the beneficial effects described above.

7.2.3 Determinations for steelhead

7.2.3.1 Federal Endangered Species Act

Given the current status of CCC steelhead DPS, the current environmental baseline for the Proposed Action, and the effects of the Proposed Action, it is concluded that the Proposed Action would adversely affect steelhead. Adverse effects associated with the Proposed Action have been avoided and/or minimized and would be expected to be small and would not jeopardize the species’ continued existence, or preclude recovery of these species.

7.3 Chinook Salmon

Early adult Chinook Salmon have returned to the Russian River as early as mid-August. The peak run generally begins in October through November, and upstream migration continues into mid-January. Spawning takes place from October through January. Eggs incubate for a longer period than for Coho Salmon and steelhead, and the incubation period occurs from November through

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[553] Wissmar, R. C. and P. A. Bisson, editors. 2003. Strategies for restoring river ecosystems: sources of variability and uncertainty in natural and managed systems. American Fisheries Society, Bethesda, Maryland.

March. After emerging from the gravel, juvenile Chinook Salmon rear in fresh water for only two to four months (February through May) before migrating downstream (February through June), compared to the more protracted freshwater rearing (1 to 2 years) of Coho Salmon and steelhead. Therefore, there is a relatively short time-period (November through June) during which fry and juveniles are susceptible to the adverse and beneficial effects of the proposed project.

Adult Chinook Salmon spawning habitat is located primarily in the upper and middle Russian River mainstem and in selected tributaries such as Dry Creek. A redd survey conducted in the mainstem in 2002 documented spawning as far downstream as Healdsburg.[554] Chinook Salmon rearing primarily occurs in the Russian River mainstem and selected tributaries such as Dry Creek, with limited rearing may be provided in the Estuary.

Similar to steelhead, several activities under the Proposed Action would benefit Chinook Salmon. Continued implementation of the Deviation and application of FIRO procedures at CVD are expected to result in conservation of cold-water pool in Lake Mendocino, which would improve water temperatures in the upper Russian River relative to prior operating conditions. The interim petitions would likewise would benefit spring rearing habitat in the upper and middle Russian River, with no effect on turbidity. Enhancement actions in Dry Creek would benefit spawning and rearing habitat that could help to offset project effects from activities such as channel maintenance. Together, these activities could provide an increase in Chinook Salmon production and survival during the freshwater period.

Adverse effects on Chinook Salmon could result from localized risks including entrainment at the Mirabel infiltration ponds and sedimentation and injury to individuals from bank stabilization activities in the mainstem Russian River; however, these effects would be avoided and/or minimized as a result of implementation of BMPs.

7.3.1 Effects of the Proposed Project on Chinook Salmon

7.3.1.1 Adult Upstream Migration

The Proposed Action would continue to provide adequate adult passage conditions within the Russian River and Dry Creek. Alterations to minimum instream releases under the interim petitions designed to protect rearing habitat may result in small effects on the early Chinook migrants.

Effects on adult Chinook Salmon migration associated with channel maintenance activities would be similar to those described above for steelhead and potential effects of these actions would be negligible.

Habitat enhancement in Dry Creek would benefit fish passage. Instream enhancement structures in Dry Creek may slightly enhance passage to Dry Creek tributaries by providing increased cover from predators and creating pools to provide refuge for migrating adults during high flows. This may help offset potential negative effects due to channel maintenance activities in this portion of

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[554] Cook, D. 2008. "Chinook salmon spawning study, Russian River Fall 2002-2007." Sonoma County Water Agency, Santa Rosa, CA.

the watershed. Thus, conditions for upstream migration are likely to improve in these streams relative to baseline conditions.

Mirabel/Wohler diversion facility operation and maintenance activities in the mainstem could affect Chinook Salmon, although prior improvements to the operations of these facilities should reduce the risk of entrapment. While uncertainties exist regarding adverse effects associated with operation of Mirabel Dam and Wohler Pool and associated predation risks, the proposed conservation measure will ensure that special studies are being implemented to better understand loss rates of outmigrating salmonids and, if necessary, measures to ensure that harm and mortality to listed salmonids are low will be implemented.

7.3.1.2 Spawning and Egg Incubation

The Proposed Action would result in similar conditions required by Chinook Salmon for spawning in the upper Russian River compared to baseline. Flood control operations at CVD would be similar to that under baseline and any potential effects associated with these operations (e.g., scour and bank erosion) would be expected to be small. Flood control operations at WSD would continue similar to that under baseline and any potential adverse effects associated with these operations (scour and bank erosion) would also be expected to be negligible.

Interim petitions and preliminary proposed Fish Flow Project would provide adequate spawning conditions for Chinook Salmon in Dry Creek relative to water management practices under Decision 1610.

Instream habitat enhancement planned for Dry Creek would also improve spawning and incubation conditions for Chinook Salmon. These actions would increase the extent of riffle and pool tail-out habitat that may serve as future spawning areas for steelhead in the mainstem. Instream habitat structures, such as large woody debris, would also help reduce the chance of redd scour during storm events, thereby increasing the overall egg-to-fry survival rate.

Flood control operations at WSD would continue similar to that under baseline and any potential adverse effects associated with these operations (scour and bank erosion) would be expected to be negligible.

7.3.1.3 Juvenile Rearing

Continued implementation of the Deviation and application of FIRO procedures at CVD are expected to result in conservation of cold-water pool in Lake Mendocino, which would improve water temperatures in the upper Russian River relative to operating conditions prior to implementing these procedures. Other flood control operational effects in the upper Russian River (ramping) under the Proposed Action would be similar or be considered a small benefit compared to baseline.

Turbidity releases in the spring and summer would be most likely to adversely affect rearing juvenile Chinook Salmon in the Russian River mainstem. Elevated turbidity could reduce visibility and impair feeding or the ability to detect predators. Increased energy expenditures would be required if it is necessary to clear sediment from the gills through “flaring,” etc.

Juveniles closer to CVD would be expected to incur the greatest impacts because the turbidity dissipates moving downstream.

Implementation of the interim petitions are not expected to adversely affect Chinook Salmon rearing conditions in Dry Creek. The slight changes in instream flows would result in negligible effects on the quantity of rearing habitat for Chinook Salmon in Dry Creek.

Effects on juvenile rearing associated with channel maintenance activities would be similar to those described above for adult upstream migration and potential adverse effects would be negligible.

Passive operation of the Santa Rosa Creek Diversion Structure would not result in the entrainment and diversion of juvenile fish since Chinook salmon are not found in this portion of the watershed.

Juvenile rearing habitat has improved in Dry Creek and its tributaries due to the implementation of the enhancements. The additional habitat enhancement planned for this region would continue to improve localized habitat complexity and benefit young Chinook Salmon through the creation of scour, plunge, and backwater pools. Pool habitat is essential for juvenile survival because it provides a refuge for high flows, cover from predators, and suitable rearing temperatures.

Construction of Dry Creek enhancements would be expected to result in temporary, adverse effects; however, these effects would be avoided and/or minimized with the implementation of BMPs, similar to implementation of prior Dry Creek enhancements.

Chinook Salmon are not known to rear in the Estuary, as a result, there would be no effect to the juvenile rearing life stage for this species.

7.3.1.4 Juvenile Downstream Migration

The Proposed Action would be expected to result in negligible effects on the downstream migration of smolts. Some potential risks remain for young Chinook Salmon as they migrate downstream (see Section 4.9.4.3, *Related Monitoring*).

There is expected to be a negligible change in juvenile downstream migration flows from implementation of the Proposed Action in the upper Russian River (implementation of the Deviation with application of FIRO procedures and interim petitions and preliminary proposed Fish Flow project). Salmonid passage flows in the lower Russian River would also remain suitable for Chinook Salmon under Proposed Action. Therefore, implementation of the Proposed Action would not substantially interfere with the movement or migration of Chinook Salmon in the upper or lower Russian River.

Effects on juvenile downstream migration associated with channel maintenance activities would be similar to those described above for adult upstream migration and potential effects from these actions would be small and not impede passage requirements.

No effects on juvenile downstream migration associated with passive operation of the Santa Rosa Creek Diversion Structure would occur.

Mirabel/Wohler diversion facility operation and maintenance activities in the mainstem could affect Chinook Salmon although prior improvements to the operations of these facilities should reduce the risk of entrapment. Smolts could be delayed at the inflatable dam if they have difficulty locating the augmented flow channel through the new fish ladder. They could also fall prey to predatory fish in Wohler Pool. While uncertainties exist regarding adverse effects associated with operation of Mirabel Dam and Wohler Pool and associated predation risks, the proposed conservation measure will ensure that special studies are being implemented to better understand loss rates of outmigrating salmonids and, if necessary, measures to ensure that harm and mortality to listed salmonids are low will be implemented.

7.3.2 Chinook Salmon Response to the Proposed Action

Beneficial effects of the Proposed Action are summarized in **Table 7-5**. Overall, the Proposed Action would be expected to improve habitat for steelhead and should play an important role in the recovery of steelhead populations in the Russian River. However, there are a few ongoing activities that could result in adverse effects (**Table 7-6**).

TABLE 7-5
POTENTIAL BENEFICIAL EFFECTS TO CHINOOK SALMON

Life-History Stage	Beneficial Effects of the Proposed Action
Adult Upstream Migration	Implementation of interim petitions
	Instream enhancement projects in Dry Creek that increase cover and high-flow velocity refuge
Spawning and Incubation	Implementation of the Deviation with FIRO procedures in combination with the tinterim petitions would conserve cold water pool, resulting in improved water temperatures in the Fall
	Instream enhancement structures in Dry Creek to maintain riffle and pool tai-lout habitats and maintains spawning gravels
Juvenile Rearing	Continued implementation of Deviation with application of FIRO procedures (at CVD) in combination with interim petitions
	Instream enhancement projects in Dry Creek
Juvenile Downstream Migration	Implementation of interim petitions in Dry Creek and Russian River

TABLE 7-6
POTENTIAL ADVERSE EFFECTS ON CHINOOK SALMON

Life-History Stage	Adverse Effects of the Proposed Action
Juvenile Rearing	Temporary, construction-related effects associated with channel maintenance activities (avoided and/or minimized)
	Temporary, construction-related effects in Dry Creek (avoided and/or minimized)
	Turbidity effects from CVD releases
Juvenile Downstream Migration	Temporary, construction-related effects associated with channel maintenance activities (avoided and/or minimized)
	Stranding during inflation of Mirabel Dam
	Predation in Wohler Pool

7.3.2.1 Integration of Project Effects on Chinook Salmon Habitat

In general, the Proposed Action would result in net improvements to Chinook Salmon and their habitat. Some potential direct effects could result in injury or mortality of some individuals, particularly migrating juveniles. Under the Proposed Action, the conditions in the Russian River system would likely support the continued survival of Chinook Salmon in the river system and would likely improve over baseline conditions.

The primary effect of the Deviations with FIRO procedures in combination with the interim petitions and Fish Flow Project in the Russian River would be to preserve cold water pool storage in Lake Mendocino thereby improving conditions in the upper Russian River for adult migration and spawning. There is the potential for considerable positive effects on Chinook Salmon spawning and rearing from the habitat enhancements being carried out in Dry Creek, and which will continue as part of the Proposed Action. Habitat enhancements in Dry Creek would continue to improve habitat and help counteract possible detrimental effects of other channel maintenance activities.

Construction of Dry Creek enhancements would be expected to result in temporary, adverse effects; however, these effects would be avoided and/or minimized with the implementation of BMPs, similar to past Dry Creek enhancements.

Although activities are expected to improve downstream migration relative to baseline conditions, there would still be potential ongoing negative effects that could impede smolt migration. For example, entrainment and stranding during the inflation of the Mirabel Dam and an increased risk of predation for fish swept into the Wohler Pool. While uncertainties exist regarding adverse effects associated with operation of Mirabel Dam and Wohler Pool and associated predation risks, the proposed conservation measure will ensure that special studies are being implemented to better understand loss rates of outmigrating salmonids and, if necessary, measures to ensure that harm and mortality to listed salmonids are low will be implemented.

7.3.3 Determinations for Chinook Salmon

7.3.3.1 Federal Endangered Species Act

Given the current status of California Coastal Chinook Salmon ESU, the current environmental baseline for the Proposed Action, and the effects of the Proposed Action, it is concluded that the Proposed Action would adversely affect Chinook Salmon, however, the Proposed Action would not adversely modify their designated critical habitat. Adverse effects associated with the Proposed Action have been avoided and/or minimized and would be expected to be small and would not jeopardize the species' continued existence, or preclude recovery of these species.

7.4 Longfin Smelt

As described in sections 5 and 6 above, Longfin Smelt detections in the Estuary have been infrequent, and as a result, their status and habitat associations are uncertain. [555,556,557] Brennan et al. (2022)[558] hypothesized that shallow tidal wetlands and sloughs likely promote larvae retention based on their presence in larger estuaries with these habitat features, where detections were more reliable. The study also concluded that high flows may transport larvae out of smaller coastal estuaries, including the Russian River, thereby reducing detectability.[559] This process would be expected to occur naturally, under the baseline, and under the Proposed Action based on the seasonal hydrology, hydraulics, and geometry of the Russian River Estuary.

Consistent with recommendations from Garwood (2017), Sonoma Water proposes to develop and implement an eDNA monitoring program focused on Longfin Smelt in the Estuary (see Section 3.10, *Conservation Measures*). The effort would include habitat stratification and eDNA sampling informed by existing understanding of Estuary hydrology, water quality, and physical habitat dynamics. Because eDNA monitoring is passive (i.e., collection of water samples for DNA extraction), it would not involve capture or handling of individuals, and therefore, would not require permits for incidental take of the species.

7.4.1 Determinations

7.4.1.1 Federal Endangered Species Act

Given the current status of Longfin Smelt, the current environmental baseline for the Proposed Action, it is determined that the Proposed Action may affect, but would not adversely affect Longfin Smelt. Critical habitat for Longfin Smelt has not been designated.

To address uncertainties with the species, Sonoma Water proposes to develop and implement an eDNA monitoring program focused on Longfin Smelt in the Estuary. Because eDNA monitoring

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[555] Garwood RS. 2017. *Op. cit.*

[556] Brennan et al. 2022. *Op cit.*

[557] Brennan, C., personal communications. 2022. *Op cit.*

[558] Brennan et al. 2022. *Op cit.*

[559] Brennan et al. 2022. *Op cit.*

is passive (i.e., collection of water samples for DNA extraction), it would not involve capture or handling of individuals, and therefore, not require permits for incidental take of the species.

7.4.1.2 California Endangered Species Act

There has been scant occurrence of Longfin Smelt in the Estuary consisting of winter detections of a few larvae and no summer captures during nearly two decades of beach seining. The Proposed Action would not affect winter conditions for Longfin Smelt in the Estuary and the use in summer appears to be very limited. Based on this environmental baseline, it is determined that the Proposed Action would not adversely impact Longfin Smelt. However, to address uncertainties with the species, Sonoma Water proposes to develop and implement an eDNA monitoring program focused on Longfin Smelt in the Estuary. Because eDNA monitoring is passive (i.e., collection of water samples for DNA extraction), it would not involve capture or handling of individuals, and therefore, not require permits for incidental take of the species.

SECTION 8

Essential Fish Habitat

8.1 Effects on Essential Fish Habitat

8.1.1 Regulatory Background

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), as amended by the Sustainable Fisheries Act of 1996, establishes a national program to manage and conserve the fisheries of the United States through the development of Federal Fishery Management Plans (FMPs), and Federal regulation of domestic fisheries under those FMPs, within the 200-mile U.S. Exclusive Economic Zone (16 U.S.C. §1801 *et seq*). To ensure habitat considerations receive increased attention for the conservation and management of fishery resources, the amended Magnuson-Stevens Act required each existing, and any new, FMP to "describe and identify essential fish habitat for the fishery based on the guidelines established by the Secretary under section 1855(b)(1)(A) of this title, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat." (16 U.S.C. §1853(a)(7)).

Essential Fish Habitat (EFH) is defined in the Magnuson-Stevens Act as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. §1802(10)). The components of this definition are interpreted at 50 C.F.R. §600.10 as follows:

- "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate;
- "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; and
- "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

Pursuant to the Magnuson-Stevens Act, each Federal agency is mandated to consult with NMFS with respect to any action authorized, funded, or undertaken, or proposed to be, by such agency that may adversely affect any EFH under this Act (16 U.S.C. §1855(b)(2)). The Magnuson-Stevens Act further mandates that where NMFS receives information from a Fishery Management Council or Federal or state agency or determines from other sources that an action authorized, funded, or undertaken, or proposed to be, by any Federal or state agency would adversely affect any EFH identified under this Act, NMFS has an obligation to recommend to such agency measures that can be taken by such agency to conserve EFH (16 U.S.C. §1855(4)(A)).

The term "adverse effect" is interpreted at 50 C.F.R. §600.810(a) as any impact that reduces quality and/or quantity of EFH and may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce quantity and/or quality of EFH. In addition, adverse effects to EFH may result from actions occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

8.1.2 Fisheries Management Plans

The Proposed Action occurs within EFH for various federally managed fish species within the Pacific Salmon FMP, the Coastal Pelagics FMP, and the Pacific Groundfish FMP (Figure 1-3). **Table 8-1** lists the FMP-managed species commonly observed in the Russian River. The Russian River basin contains habitat necessary to Pacific salmon for spawning, breeding, and feeding or growth while rearing. Pacific salmon use the Russian River, its tributaries, and its estuary. Species managed under the Coastal Pelagics and Pacific Groundfish FMPs use the Russian River Estuary primarily for juvenile rearing, though some species may use the area for spawning as well. In addition, the Proposed Action occurs within areas designated as Habitat Areas of Particular Concern (HAPC) for species managed under the Pacific Groundfish FMP. HAPC are described in the regulations as subsets of EFH which are rare, particularly susceptible to human induced degradation, especially ecologically important, or located in an environmentally stressed area. Designated HAPC are not afforded any additional regulatory protection under Magnuson Stevens Act; however, Federal projects with potential adverse impacts to HAPC will be more carefully scrutinized during the consultation process. As defined in the Pacific Groundfish FMP, the Russian River watershed contains estuary habitat – a habitat designated as a HAPC. Estuaries are important elements of Pacific Groundfish EFH, as estuaries provide prey items, foraging areas, habitat complexity, nursery areas, and refugia. Estuaries provide the same vital elements for species managed under the Pacific Salmon and Coastal Pelagic FMPs, as well as many other fish species.

8.1.3 Effects of the Proposed Action

The preceding BA fully analyzed the Proposed Action and its effects on federally listed Russian River species and habitat. The following is a summary of the effects associated with the Project that have the potential to impact EFH within the action area.

8.1.3.1 Pacific Salmon

Pacific Salmon EFH is designated throughout all accessible reaches of the action area. Potential effects to Coho Salmon and Chinook Salmon habitat due to the Proposed Action are described in the preceding BA (see Sections 7.1, *Coho Salmon* and 7.3, *Chinook Salmon*). Pink Salmon are observed in the Russian River sporadically; however, that species was not included in the preceding BA as that species is not listed as threatened or endangered under the FESA. Additionally, if Pink Salmon were to be present they would likely use the Estuary similarly to

Chinook Salmon, as adult and smolt migration times and estuarine residences times are similar between the two species.[560]

TABLE 8-1
RUSSIAN RIVER WATERSHED FISH SPECIES COVERED UNDER RELEVANT FISHERIES MANAGEMENT PLANS

Fishery Management Plan	Common Name	Scientific Name
Pacific Coast Salmon	Chinook Salmon	*Oncorhynchus tshawytscha*
	Coho Salmon	*Oncorhynchus kisutch*
Costal Pelagic	Topsmelt	*Atherinops affinis*
	Pacific herring	*Clupea pallasii*
	Surf smelt	*Hypomesus pretiosus*
Pacific Groundfish	Pacific sand sole	*Psettichthys melanostictus*
	Starry flounder	*Platichthys stellatus*
	Cabezon	*Scorpaenichthys marmoratus*
	Rockfish sp.	*Sebastes sp.*
	Pacific sanddab	*Citharichthys sordidus*
	English sole	*Parophrys vetulus*
	Lingcod	*Ophiodon elongatus*
	Kelp greenling	*Hexagrammos decagrammus*

SOURCE: J. Martini-Lamb and Manning, D.J. editors. 2020. Russian River Biological Opinion Status and Data Report Year 2017. Sonoma County Water Agency, Santa Rosa, CA. 401 p.

The condition of Pacific Salmon EFH would be improved throughout the Russian River watershed with implementation of the Proposed Action. Dry Creek enhancements would improve habitat conditions for all stages of the freshwater lifecycle in a beneficial manner and should help facilitate their recovery; particularly for Coho Salmon (see Section 3.8, *Dry Creek Habitat Enhancement*). Implementation of the Fish Flow project would have a beneficial effect on EFH by providing better conditions for spawning and upstream migration, increasing the probability that abundances in this region would increase in the future (see Section 6.2, *Water Supply Operations*). Additionally, implementation of the Deviation and application of FIRO procedures at CVD are expected to result in conservation of cold-water pool in Lake Mendocino, which would improve water temperatures in the upper Russian River resulting in benefits to Pacific Salmon EFH.

Construction of Dry Creek enhancements would be expected to result in temporary, minimal adverse effects, which would be avoided and/or minimized with the implementation of BMPs, similar to past Dry Creek enhancements. Additionally, some of the channel maintenance actions may result in minimal adverse effects on EFH. No substantial adverse effects that to EFH are expected to result as part of the Proposed Action. Given the overall improvements to instream

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[560] Heard. W.R. 1991. Life History of Pink Salmon. Pages 119-230 in C. Groot and L Margolis editors. Pacific Salmon Life Histories. University of British Columbia Press, Vancouver, B.C. 564 pages.

habitat through enhancement actions and operations with the Fish Flow project, any adverse effects to EFH would be minimal.

8.1.3.2 Coastal Pelagics and Pacific Groundfish

The proposed project occurs within EFH for various federally managed marine fish species within the Coastal Pelagics FMP and the Pacific Groundfish FMP. The extent of EFH as designated under these two FMPs is shown in Figure 1-3. Marine species managed under the Coastal Pelagics FMP with designated EFH in the Russian River Estuary include topsmelt, Pacific herring, and surf smelt (Table 8-1). Marine species managed under the Pacific Groundfish FMP with designated EFH in the Russian River Estuary include starry flounder, Pacific sanddab, cabezon, lingcod, kelp greenling, and rockfish. Potential impacts to these marine species from the proposed project are assessed here.

Many marine EFH species utilize estuaries, primarily for juvenile rearing, though some species may use estuaries for spawning as well. As defined in the Pacific Groundfish FMP, the Russian River watershed contains estuary habitat – a habitat designated as a HAPC. Estuaries are important elements of Pacific Groundfish EFH, as estuaries provide prey items, foraging areas, habitat complexity, nursery areas, and refugia. Estuaries provide the same vital elements for species managed under the Coastal Pelagic FMP, as well as many other fish species and macroinvertebrates, such as Dungeness crab.

Following breaching events, the abundance and diversity of marine and estuarine fish increase in the action area as marine fish move into the open Estuary. Following reformation of the barrier beach the abundance and diversity of marine and estuarine fish decreases over time due to rapidly changing habitat conditions (e.g., salinity, temperature, dissolved oxygen).[561] Additionally, when the barrier beach forms, marine fish become less dispersed in the Estuary and are concentrated near the river mouth where the highest salinities occur.[562]

The abundance of most marine species (e.g., cabezon, ling cod, rockfish) in the Estuary is low as these species are dependent on marine conditions. Also, pelagic fish (e.g., Pacific herring, surf smelt) are rarely caught in the Estuary.[563] However, Dungeness crab and starry flounder prefer brackish to freshwater. These two species use the Estuary for rearing and can be abundant during summer. The Proposed Action would continue to manage the Estuary so that the naturally formed barrier beach persists for a longer duration, to either enable a full transition from tidally influenced marine habitat to productive freshwater estuarine lagoon habitat or maintain stratified conditions with increased stable freshwater habitat in the upper portion of the water column. Managing the Estuary as proposed would reduce the number of times that species managed under the Coastal Pelagics, Pacific Groundfish FMPs, and other marine species have opportunity to access the Estuary and utilize suitable habitat that is present under tidally influenced conditions. Additionally, prolonged closure and conversion to freshwater lagoon conditions may locally affect the distribution of marine species within the Estuary. However, from a population and

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[561] Sonoma Water, 2010. Russian River Estuary Sandbar Breaching – 2009 Monitoring Report. January 2010.

[562] Martini-Lamb, J. and Manning, D.J. editors. 2022. *Op. cit.*

[563] Martini-Lamb, J. and Manning, D.J. editors. 2022. *Op. cit.*

habitat area standpoint, the numbers of marine fishes in the relatively small Estuary are minima compared to the inshore coastal waters and the San Francisco Bay. Therefore, these localized effects from Estuary management to fish managed under the Coastal Pelagic, and Pacific Groundfish FMPs, as well as other marine fish species and macroinvertebrates that use portions of the Estuary are unlikely to represent a substantial adverse effect.

As part of the Proposed Action, Sonoma Water will continue to implement and revise, in consultation with NMFS, an adaptive management plan to better understand the potential effects associated with the Proposed Action. The adaptive management plan incorporates monitoring and adaptive management to better understand, minimize, or otherwise mitigate (within the context of the overall goals) any adverse effects estuary management may have regarding Estuary water surface elevation, water transport through the barrier beach, estuarine water quality, and habitat quantity and quality.

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SECTION 9

Marine Protected Areas

9.1 Marine Protected Areas

The Russian River State Marine Recreational Management Area (SMRMA) and Russian River State Marine Conservation Area (SMCA) are two adjoining marine protected areas in the Russian River Estuary. The Russian River mouth is located within the SMCA, which extends along the coastline, and the SMRMA extends from below the mean high tide line upstream to the Highway 1 Bridge (**Figure 9-1**). The combined area of these marine protected areas is 3.73 km^2: with 0.93 km^2 in the SMRMA and 2.80 km^2 in the SMCA.

The areas are two of the 22 marine protected areas and 3 SMRMAs adopted by CDFW in August 2009 (codified as State law in May 2010), during the second phase of the Marine Life Protection Act Initiative (MLPAI).[564] The two Russian River reserves are part of the north central coast marine protected area network; established by CDFW on May 1, 2010.

9.1.1 Regulatory Background

In 1999, the California legislature approved, and the governor signed the Marine Life Protection Act (MLPA) (Stats. 1999, Chapter 1015).[565] The MLPA directed the state, through the Fish and Game Commission (Commission), to redesign California's system of marine protected areas to increase its coherence and effectiveness in protecting the state's marine life and habitats, marine ecosystems, and marine natural heritage, as well as to improve recreational, educational, and study opportunities provided by marine ecosystems. The goals of the MLPA are:

- to protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems;
- to help sustain, conserve, and protect marine life populations, including those of economic value, and rebuild those that are depleted;
- to improve recreational, educational, and study opportunities provided by marine ecosystems that are subject to minimal human disturbance, and to manage these uses in a manner consistent with protecting biodiversity;
- to protect marine natural heritage, including protection of representative and unique marine life habitats in California waters for their intrinsic value;

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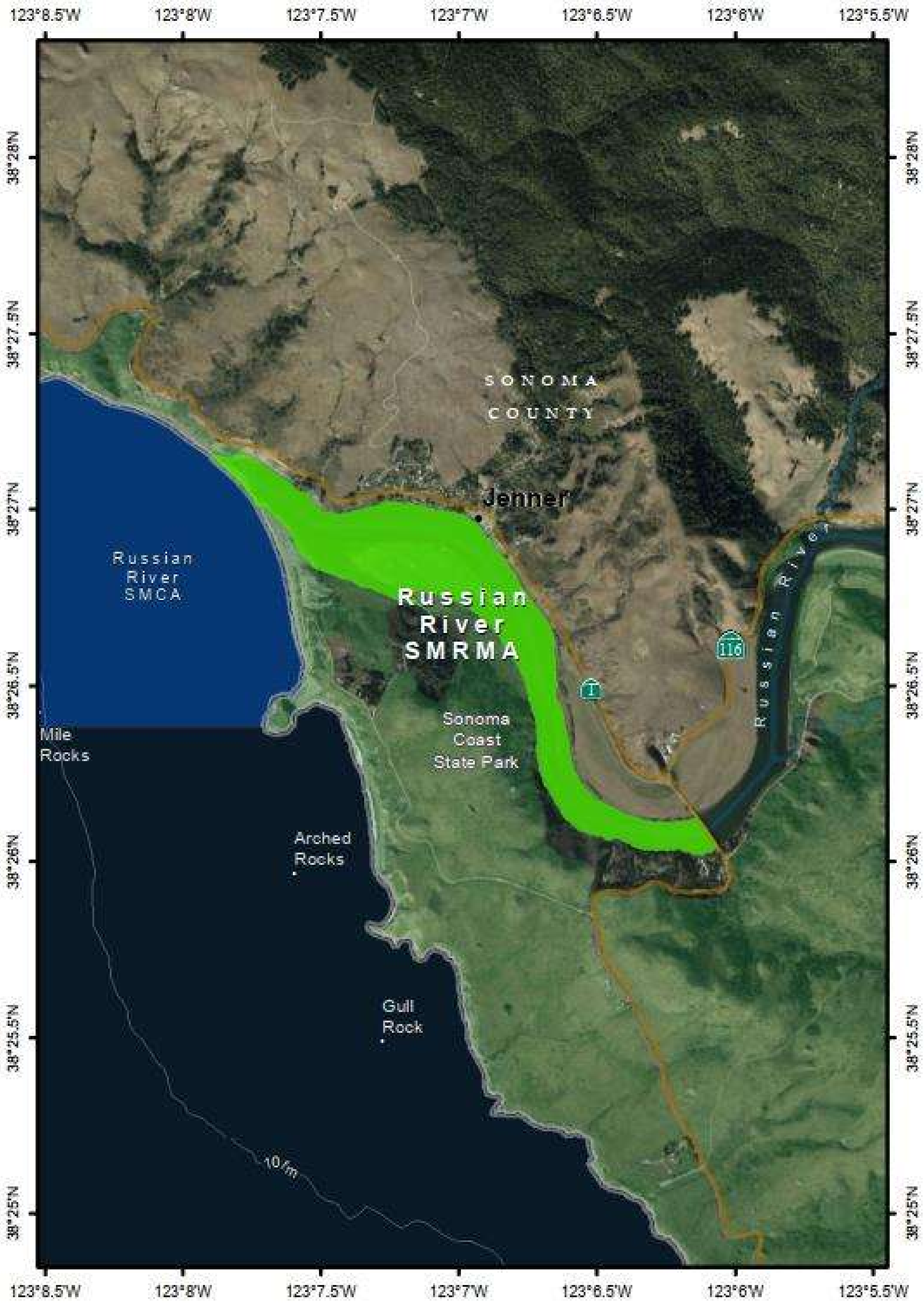
[564] The MLPAI was a collaborative public process to create a statewide network of protected areas along California's coastline.

[565] The MLPA can be found in Chapter 10.5 of the California Fish and Game Code, Sections 2850 to 2863.



SOURCE: CDFW (2022)

Russian River Biological Assessment

Figure 9-1

Russian River Marine Protected Areas

- to ensure California's marine protected areas (MPAs) have clearly defined objectives, effective management measures, and adequate enforcement, and are based on sound scientific guidelines; and
- to ensure that the state's MPAs are designed and managed, to the extent possible, as a network.

In addition, the MLPA required the California Department of Fish and Game (CDFG) (now CDFW) to prepare a master plan to guide the planning, adoption, and implementation of an improved statewide MPA network. The MLPA specified components of the master plan, including recommendations for the extent and types of habitats that should be represented within MPAs; made recommendations on the minimum size of SMRs or other classifications of MPAs to accomplish MLPA goals; and included an analysis of existing state MPAs. A MLPA master plan framework was adopted by the Commission in August 2005. This framework was expanded into the MLPA Master Plan for Marine Protected Areas, adopted by the Commission in February 2008.

9.1.2 Marine Protected Areas

An MPA refers to a named, discrete geographic marine or estuarine area seaward of the high-tide line or the mouth of a coastal river, including any area of intertidal or subtidal terrain, together with its overlying water and associated flora and fauna, with regulations that are more restrictive than the general regulations in the general area and that are designed to protect or conserve marine life and habitat. MPAs are primarily intended to protect or conserve marine life and habitat; therefore, they are a subset of marine managed areas (MMAs), which are broader groups of named, discrete geographic areas along the coast that protect, conserve, or otherwise manage a variety of resources and uses, including living marine resources, cultural and historical resources, and recreational opportunities.

MPA designations used during MLPA planning include state marine reserves (SMRs), state marine parks (SMPs), state marine conservation areas (SMCAs), and state marine recreational management areas (SMRMAs). The Commission has the statutory authority to designate SMRs, SMCAs, and SMRMAs. The other MPA classification, SMPs, may only be created, modified, or deleted under the authority of the Park and Recreation Commission. In addition to having somewhat different purposes, each type of MPA represents a different level of restriction on activities within MPA boundaries.

9.1.2.1 Russian River State Marine Conservation Area (SMCA)

SMCAs differ from other MPAs in their purposes and types of restrictions as an SMCA allows for some level of recreational and/or commercial take. The restrictions on fishing may vary with the focal species, habitats, and objectives of an individual MPA within a region, and may, for example, be in the form of restrictions on the catch of particular species and/or the use of certain types of fishing gear. SMCAs may be useful in protecting more sedentary, benthic (bottom-dwelling) species, while allowing the harvest of pelagic finfish species. Another use of an SMCA could be to allow the continued use of traps, which typically have relatively low bycatch rates and are more efficient for harvesting some species of invertebrates, while prohibiting the harvest of finfish species of concern by trawls, which typically have relatively high bycatch rates. In the

Russian River SMCA, the taking of all living marine resources is prohibited, except the recreational and commercial trapping of Dungeness crab (*Metacarcinus magister*) and the recreational taking of Surf Smelt (*Hypomesus pretiosus*) by hand-held dip nets or beach nets.

One of the goals for Russian River SMCA is to help protect anadromous fish, such as steelhead and salmon, when they return to the Russian River to spawn. These fish collect at the river's mouth to await the opening of the sandbar with heavy winter rains. The conservation area includes expanses of sandy seafloor that attract bat rays, surfperch, and Dungeness crab. The sandy seafloor is flanked on either side by rocky reefs where limpets, anemones, and lingcod (see Section 4.3.7.10, *Biological Monitoring*). The Russian River SMCA shares an eastern border with Russian River SMRMA and overlaps a portion of the Greater Farallones National Marine Sanctuary.

9.1.2.2 State Marine Recreational Management Area (SMRMA)

In an SMRMA, activities that would compromise the recreational value of an area are restricted. Recreational opportunities may be protected, enhanced, or restricted, while preserving the basic resource values of the area in question. SMRMAs, which are marine managed areas but not marine protected areas, are useful management tools in areas where certain recreational use is allowed, but extraction of subtidal living marine resources is prohibited. For example, the use of this designation allows waterfowl hunting, while preserving the subtidal resources in a manner similar to a SMR. In the Russian River SMRMA, the taking of all living marine resources except recreational hunting of waterfowl is prohibited, unless otherwise restricted by hunting regulations.

As with the Russian River SMCA, the specific objectives for the Russian River SMRMA are to protect nursery habitat for rearing salmonids and other estuarine species and to protect communities associated with areas of diverse estuarine habitats including open channels, mudflats, and eelgrass beds. The Russian River SMRMA is also intended to protect salmonid resources subject to fishing impacts when a closed Estuary condition facilitates periods of juvenile rearing.

9.1.3 Effects on Marine Protected Areas

CDFW previously noted that Sonoma Water's past alterations to their estuary management practices, including revising the maximum water surface elevation to 9 feet and minimizing artificial breaching, would benefit habitat for rearing salmonids and other species by providing access to additional wetted habitat.[566] Under the Proposed Action, Sonoma Water would continue to perform adaptive beach management following natural closures throughout the year, focusing on maximizing salmonid habitat while minimizing flood risk to low-lying properties adjacent to the Estuary. Importantly, Sonoma Water does not impact the frequency of closures or cause closures to occur. Under current the beach management program, no stranding of juvenile fish has been observed during the flushing period. Nor has any significant water quality impairment resulted such that adverse effects on aquatic species were observed. It is likely that the effects of flushing during a managed outlet condition and those that occur during natural breach events are

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[566] Sonoma Water, 2011. Russian River Estuary Management Project – Final EIR. CDFW, Bay Delta Region, Comment Letter. February 18, 2011.

similar. Adaptive beach management also minimizes the potential for flooding of adjacent roadways and infrastructure, which could result in the introduction of contaminants into the Estuary MPAs.

Thus, the Proposed Action is compatible with several of the MLPA goals including the following:

- Conservation of biological diversity and abundance of marine life;
- Conservation of health of marine ecosystems and populations; and
- Protection of representative marine life and therefore marine natural heritage.

In addition, continued adaptive management is directly compatible with the MLPA intent of managing MPAs using ecosystem-based management principles and monitoring. The Proposed Action is also compatible with the MLPA in that it would assist in the effective management of the two Russian River MPAs. In total, the Proposed Action is unlikely to adversely affect or directly conflict with any of the goals outlined in the MLPA or with the ability of either MPA to protect rearing salmonids.

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SECTION 10

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Appendix A

Non-Discretionary and Discretionary Federal Actions at Coyote Valley Dam and Warm Springs Dam

Appendix A – Non-Discretionary and Discretionary Federal Activities at Coyote Valley and Warm Springs Dams

Prepared by U.S Army Corps of Engineers, August 2023

Authorized Purposes:

The responsibility to maintain Civil Works structures so that they continue to serve their Congressionally authorized purposes is inherent in the authority to construct them and is therefore non-discretionary. Only Congressional actions to de-authorize the structures can alter or terminate this responsibility and thereby allow the maintenance of the structures to cease.

Chief of Engineers Report, May 9, 1950, In this document, the Chief of Engineers recommended that Coyote Valley Dam be constructed "for flood control and water supply." Page 5. The obligation to flood control was prioritized in this document, as the Chief explained that the operations at the Dam were "subject to flood control priority," especially during flood season where the "reservoir would be operated to provide the highest possible degree of flood protection." *Id*; 36. Furthermore, all other benefits to the project would be "collateral and incidental," including the positive benefits to the anadromous fish population in the Russian River. 46, 48. Specifically, the positive benefit stems from the supplementary flows during summer months, as corroborated by U.S. Fish and Wildlife reporting, and is seen through the supplementation of the fish population for recreational fishing. 60-61.

Flood Control Act of 1950, Congress authorized Coyote Valley Dam in the Russian River Basin for flood control, water conservation and related purposes. Section 204 of the Flood Control Act of 1950. The legislation further authorized an ultimate plan of improvement "substantially in accordance with" the related Chief's recommendations that consisted of : (1) a multiple-purpose reservoir on the East Fork of the Russian River at Coyote Valley; (2) channel stabilization works along the Russian River and its tributaries; and, (3) a multiple-purpose reservoir on Dry Creek. Pub. L. No 81-516, Chief of Engineer's Report, House Doc. Number 585, p.7 (May 9, 1950).

Flood Control Act of 1962, Congress authorized Warm Springs Dam in the Russian River Basin for flood control, water supply, and recreation. Section 203 of the Flood Control Act of 1962. Pub. L. No. 87-874 in accordance with the Chief of Engineer's Report, House Doc. Number 547 (Sept. 12, 1962). It was amended by section 95 of the Water Resources Development Act of 1974 to compensate for fish losses on the Russian River . . ." Pub. L. No. 93-251 (1974). It was further amended by [Dry Creek Legislation].

Engineering Regulation (E.R.) 1100-2-240 states that "water control plans ... shall be developed in concert with all basin interests which may be impacted by or influence project regulation" and that "[t]hese considerations should be addressed by a water control manual." The Corps is expected to balance all of the competing interests in a way that best promotes the public good.

Engineering Manual (E.M.) 1110-2-3600*, 2017*, provides guidance and imposes requirements on water management for all Corps owned and operated reservoirs, locks, dams, and other water control projects in which water storage is managed and operated for multiple authorized purposes such as flood risk management, navigation, and other uses. It also applies to Corps actions in developing water control plans and manuals . . . subject to Corps direction pursuant to ***Section 7 of the Flood Control Act of 1944.***

Coyote Valley Dam and Lake Mendocino Water Control Manual Russian River, California*, 1986, amended 2006.* The Coyote Valley Dam and Lake Mendocino Project is operated for flood control and water conservation to meet the following objectives: "(a) to prevent flood flows on the East Fork Russian River from contributing to overbank flood stages on the Russian River below Coyote Valley Dam, insofar s possible; (b) to provide the maximum amount of water conservation storage without impairment of the flood control functions of the reservoir; (c) to maintain a minimum continuous flow of 25 cfs immediately below Coyote Valley Dam; (d) to maintain discharge of 150 cfs or inflow to the reservoir whichever results in the lower reservoir release at the junction between the east and west forks of the Russian River; (e) to maintain a minimum discharge of 125 cfs at the Russian River near Guerneville." Page VII-1 of WCM. The "major constraints" of the Water Control Plan, which are not subject to change or modification, are 1) "Releases from Coyote Valley Dam insofar as possible will be restricted so that the flow at Hopland does not exceed 8,000 cfs" and 2) "Rates of changes in releases from Coyote Valley Dam are limited to 1,000 cfs per 1 hour. This is due to the physical restraints of the landscape and are necessary to permit orderly evacuation of personnel, property, livestock, etc., in advance of rising water downstream, and to minimize bank sloughing and caving as the flow recedes after an extended period of bankful flows. Pages VII-1, 5 of WCM. Flood flows for normal and emergency releases are mandated by section 7-05 of the WCM, page VII-2.

Other Specific Non-Discretionary Acts:

The Corps inspects the Coyote Valley Dam to ensure their safety and integrity, and to take the minimal maintenance actions needed to ensure that the dam can continue to serve its Congressionally authorized purposes. Corps non-discretionary activities and associated authorities pertinent to Coyote Valley Dam are described below.

National Dam Inspection Act of 1972, Pub. L. No. 92-367, Established a national program to protect human life and property from the hazards of improperly constructed or poorly maintained dams (GAO 1977). Under this Act, the secretary of the Army, acting through the Corps of Engineers, was directed to inspect all dams in the U.S., with a few minor exceptions. For the purpose of determining whether a dam (including the waters impounded by such dam) constitutes a danger to human life or property, the law states that the Secretary of the Army shall take into consideration the possibility that the dam might be endangered by overtopping, seepage, settlement, erosion, sediment, cracking, earth movement, earthquakes, failure of bulkheads, flashboards, gates on conduits, or other conditions which exist or which might occur in any area in the vicinity of the dam.

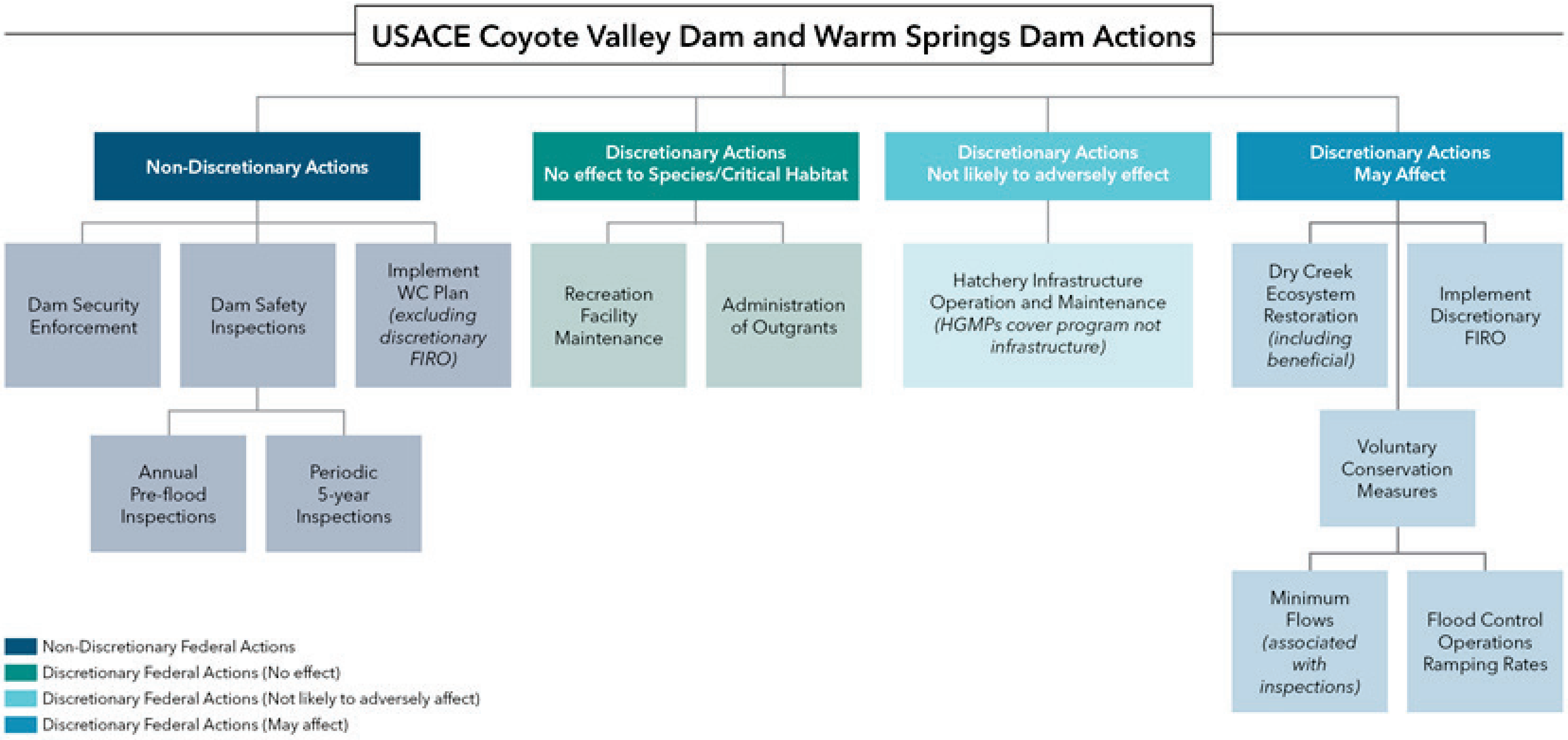
National Dam Safety Program Act of 1996, Pub. L. No. 104-303, as part of the Water Resources Development Act of 1996 authorized the Secretary of the Army to undertake a national program of inspection of dams. The objectives of the Program are to 1) ensure that new and existing dams are safe through the development of technologically and economically feasible programs and procedures for national dam safety hazard reduction; (2) encourage acceptable engineering policies and procedures to be used for dam site investigation, design, construction, operation and maintenance, and emergency preparedness; (3) encourage the establishment and implementation of effective dam safety programs in each State based on State standards. The Federal element of the Program shall

incorporate the activities and practices carried out by Federal agencies under Section 7 of
13 the Act to implement the Federal Guidelines for Dam Safety.

Engineering Regulations (E.R.) 1110-2-1156, 2003, USACE – Engineering and Design Safety of Dams – Policy and Procedure. Requires that the Corps conduct two different types of regular inspection: (1) pre-flood inspections; and (2) periodic inspections every 5 years. These inspections are conducted to address the legal requirement that the Corps shall maintain in good order and repair Coyote Valley Dam and outlet facility in accordance with its authorized purposes. At the onset of each inspection, CVD water surface elevation and the maximum pool elevation attained during the season, as well as mean total outflow, weather conditions and air temperature are recorded. For inspection and maintenance, the O&M Manual states that periodic inspections shall be made as required, to determine maintenance measure necessary to insure serviceability of the facility during flood conditions. Such inspections shall be made immediately prior to the beginning of the flood season, and immediately after each high water period. Immediate steps shall be taken to correct dangerous conditions observed during such inspections, and regulator maintenance repair measure shall be accomplished during the appropriate seasons determined by the Corps.

2013 Yuba River Biological Assessment (referencing Daguerre Point Dam and Englebright Dam O&M Manuals), The San Francisco District has specifically used this document to inform the discretionary/non-discretionary flow chart as part of the reinitiation of consultation for the Russian River. The Yuba River Biological Assessment specifically outlines activities that are nondiscretionary for both Englebright Dam and Daguerre Point Dam in the Sacramento District. This categorization was upheld by the Eastern District Court of California, ruling that even though there were authorizations that the plaintiff claimed gave the Corps "broad discretion" to do activities such as carrying out a "program to improve environmental quality," the Corps did not have discretion to "discontinue dam inventory and safety inspections." *Friends of the River v. Nat'l Marine Fisheries Serv., et al.*, 293 F. Supp.3d 1151, 1169 (E.D. Cal. 2018). Therefore, "the Corps properly classified these actions as non-discretionary." *Id*. In this document, the Corps outlines inspections of the pool, facilities, and crest, among other features, the creation of safety programs, and the security of the dams all as non-discretionary activities, and therefore not subject to ESA consultation.

Figure A-1. Non-Discretionary and Discretionary Federal Activities at Coyote Valley and Warm Springs Dams



Appendix B

Interim Water Rights Petition Hydrologic Index

APPENDIX B – INTERIM WATER RIGHTS PETITION HYDROLOGIC INDEX

SONOMA COUNTY WATER AGENCY

TECHNICAL MEMORANDUM

DATE: JULY 28, 2023

SUBJECT: INTERIM WATER RIGHTS PETITION HYDROLOGIC INDEX

Purpose

This technical memorandum provides a description of the proposed Russian River hydrologic index that Sonoma Water intends to include in the interim water rights petitions. The proposed hydrologic index will supersede State Water Resources Control Board Decision 1610 (D-1610)and will set the minimum instream flow requirements for the Upper Russian River, Dry Creek, and Lower Russian based on Lake Mendocino storage levels.

Methodology

Sonoma Water engineering staff utilized its Russian River reservoir/river operations model referred to as the Russian River System Model (RR ResSim) to develop and test the proposed hydrologic index. RR ResSim simulates reservoir operations with a daily time step over a range of hydrologic conditions. The proposed hydrologic index was designed to closely capture hydrologic conditions in the Russian River watershed and increase water supply reliability compared to the D-1610 hydrologic index that primarily relies on cumulative inflow into Lake Pillsbury in the Eel River watershed. The proposed hydrologic index evaluates Lake Mendocino storage against storage thresholds to determine the water supply condition in the Russian River. The storage thresholds were designed based on a water supply analysis of Lake Mendocino storage by modeling a simulated historical hydrologic dataset and a 1 in 100-year synthetic drought hydrologic dataset using the Russian River ResSim model (RR ResSim).

Potter Valley Project Imports

Projected PVP imports (or diversions) by Pacific Gas & Electric are simulated using the Potter Valley System Model (PVP ResSim). The PVP ResSim model was developed by the Water Supply Working

Group as part of Congressman Jared Huffman's PVP Ad Hoc Committee. It was used for a PVP/Russian River operations alternatives analysis that met the Ad Hoc's objective of developing a Two-Basin solution. The simulated diversions capture current operations based on changes to PVP that are described below.

Since October 2021, PVP normal operations have been interrupted by the failure of the transformer bank at the PVP powerhouse. PG&E has indicated that it does not intend to repair/replace the transformer bank based on costs to its rate payers and that they are in the process of surrendering FERC operating license. This has resulted in PG&E no longer making discretionary transfers through the project for power generation and limiting the transfers to their license obligations for minimum release requirements into the East Fork Russian River and water supply deliveries to the Potter Valley Irrigation District.

Furthermore, in March 2023, PG&E informed FERC that they will no longer close the spillway gates on Scott Dam in the spring due to seismic concerns of dam. This reduced the total storage capacity of Lake Pillsbury from approximately 77,000 ac-ft to approximately 56,000 ac-ft. The reduction in storage capacity going into the summer season has required PG&E to request flow variances to reduce releases from Scott Dam in order to manage the reservoirs cold water pool. Cold water releases are essential for supporting habitat for ESA listed Steelhead and salmon that rear downstream of Scott Dam in the late summer and early fall.

For the development of the proposed hydrologic index, it is assumed that PG&E will be operating PVP consistent with their operations outlined in their 2023 Flow Variance Request submitted to FERC. These operations attempt to preserve Lake Pillsbury's cold water pool by reducing PVP diversions from a maximum of 130 cfs diversion in the summer to a an assumed maximum diversion of 55 cfs, an approximately 18,000 acre-feet reduction in summer diversion volume. This reduction in diversions can continue into a dry fall and winter if Lake Pillsbury storage does not recover to 36,000 acre-feet after October 1st.

Hydrologic Index Design

The proposed hydrologic index was designed to meet three objectives: (1) capture hydrologic conditions in the Russian River watershed (2) threshold evaluation dates remain similar to D1610 hydrologic index evaluation dates and (3) Lake Mendocino storage will reliability not be depleted during a 1 in 100 year design drought.

The proposed hydrologic index will evaluate Lake Mendocino storage against storage thresholds to determine the water supply condition that the sets the minimum instream flow requirement for the Russian River. Lake Mendocino storage was determined to be a suitable index for the Russian River due to its location as the upstream point in the watershed as well as its relatively low storage capacity, which results in its water supply reliability being very sensitive to changes in the watershed and PVP Eel River imports.

Storage threshold evaluation dates were selected to be similar to the D1610 hydrologic index evaluation dates. The proposed index will evaluate storage thresholds on the first of the month January through February, then first and middle of the month from March through May, then the first of the month for June and October through December. The additional evaluation days during March through May allows the hydrologic index to react more quickly to dry spring conditions that may result if Lake Mendocino storage starting to decline earlier than average conditions. The October through December evaluation dates serve the same purpose as D1610 as they capture abnormally dry winters. However, the proposed hydrologic index can adjust the water supply condition for the Upper River, Dry Creek, and Lower River to any drier or wetter schedule, while D1610 can only adjust the Upper River water supply condition from a Normal to Dry condition during the October through December evaluation period.

Increasing Lake Mendocino water supply reliability was the main objective when designing the proposed hydrologic index. The storage threshold values were developed to achieve a minimum carry over storage on October 1st that would be sufficient to prevent storage from being depleted in the event of a subsequent 1 in 100 year design drought. This involved two steps: (1) determine the minimum carry over needed for a subsequent synthetic 1 in 100 year drought, (2) simulate the 107 years of hydrologic data through the RR ResSim model to determine if all years meet the minimum carry over storage criteria.

The minimum carry over Lake Mendocino storage needed for a subsequent 1 in 100 year drought was determined using three different scenarios simulated in RR ResSim. Each simulation runs from October 1st through December 31st of the following water year for a total of 15 months, with the synthetic drought used as the input hydrology. Each scenario was initiated with a different water supply condition (Normal, Dry, and Critical) which stayed constant until January 1st when all scenarios switched to a Critical water supply condition. The PVP diversions were set to the appropriate water supply condition based on the scenario. Initial storage for Lake Mendocino was set high enough for each scenario so that the reservoir would not be depleted during the simulation. All simulated storage values were then adjusted lower so that the lowest storage was equal to the depleted reservoir storage value of approximately 2,100 ac-feet (Figure 1). The result is a time series of minimum storage values required to survive the 1 in 100 year synthetic drought starting on October 1st for each scenario (Figure 2). For example, to maintain a normal water supply condition from October 1st through December 31st and not deplete the reservoir in a following 1 in 100 drought year, Lake Mendocino will require a minimum storage of approximately 60,500 ac-ft on October 1st. The absolute minimum required storage values to not deplete the reservoir are shown in the Critical column of Figure 6, with approximately 39,000 ac-ft required on October 1st.

Storage thresholds for the proposed hydrologic index were developed using RR ResSim by simulating Lake Mendocino storage for the 107 year hydrologic record. The storage threshold values were iterated to achieve Lake Mendocino October 1st carry over storages that are greater than the minimum required calculated in the 1 in 100 year drought analysis, while maintaining even distribution of water supply occurrences over the calendar year. The iterations resulted in storage thresholds where simulated Lake Mendocino storage on October 1st exceeded the minimum required in all but one year (Figure 3). The two years that did not meet the minimum required October 1st storage are 1924 and 1977. Water year 1977 was significantly drier than 1 in 100 year synthetic drought and was determined to be too conservative to not meet the minimum storage requirement. Water year 1924 was abnormally dry in the Lake Pillsbury watershed, which resulted in a depleted reservoir in the early fall and the PVP diversions dropping to zero cfs.

The final storage thresholds for the proposed hydrologic index are shown in Figure 4. The thresholds were finalized iterations resulting in a distribution of water supply conditions that are shown in Figure 5. April through December time periods with Normal water supply condition ranges between 32% and 59%, Dry conditions between 33% and 55%, and Critical condition between 7% and 14%. From January through March there is more variation in the water supply condition distribution due the storage thresholds being limited by the Lake Mendocino conservation pool. The RR ResSim model assumes Lake Mendocino can store water up to the maximum that is authorized under the major deviation limit that is currently in place and is expected to be formalized in a water control manual update. However, the storage thresholds are set to the conservation pool because Sonoma Water does not have operational control above that storage level. The simulation results show that for February, Lake Mendocino sees large enough inflows to increase storage above the conservation pool in 87% of the years of the historical dataset. The occurrence of Normal water supply conditions in the summer were decreased compared to the fall to allow higher flows during steelhead and salmonid outmigration.

Figure 1: Lake Mendocino 1 in 100 Year Drought Analysis

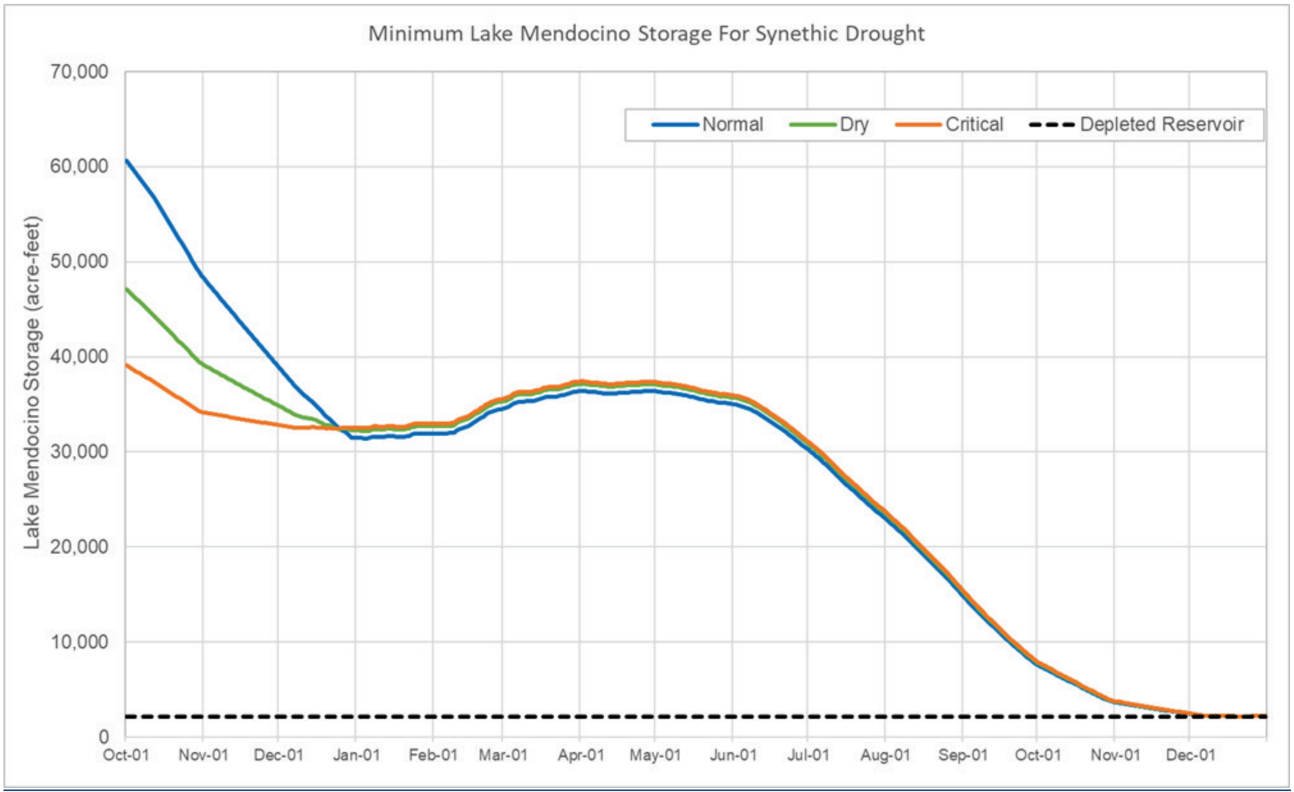


Figure 2: Minimum Required Lake Mendocino Storage for 1 in 100 year Drought

Minimum Required Lake Mendocino Storage (ac-ft)			
	Initial Water Supply Condition		
	Normal	Dry	Critical
October 1st	60,678	47,126	39,082
November 1st	48,216	39,123	34,150
December 1st	38,875	34,831	32,829
January 1st	31,468	32,248	32,535

Figure 3: Exceedance Plot of Simulated October 1st Lake Mendocino Storage

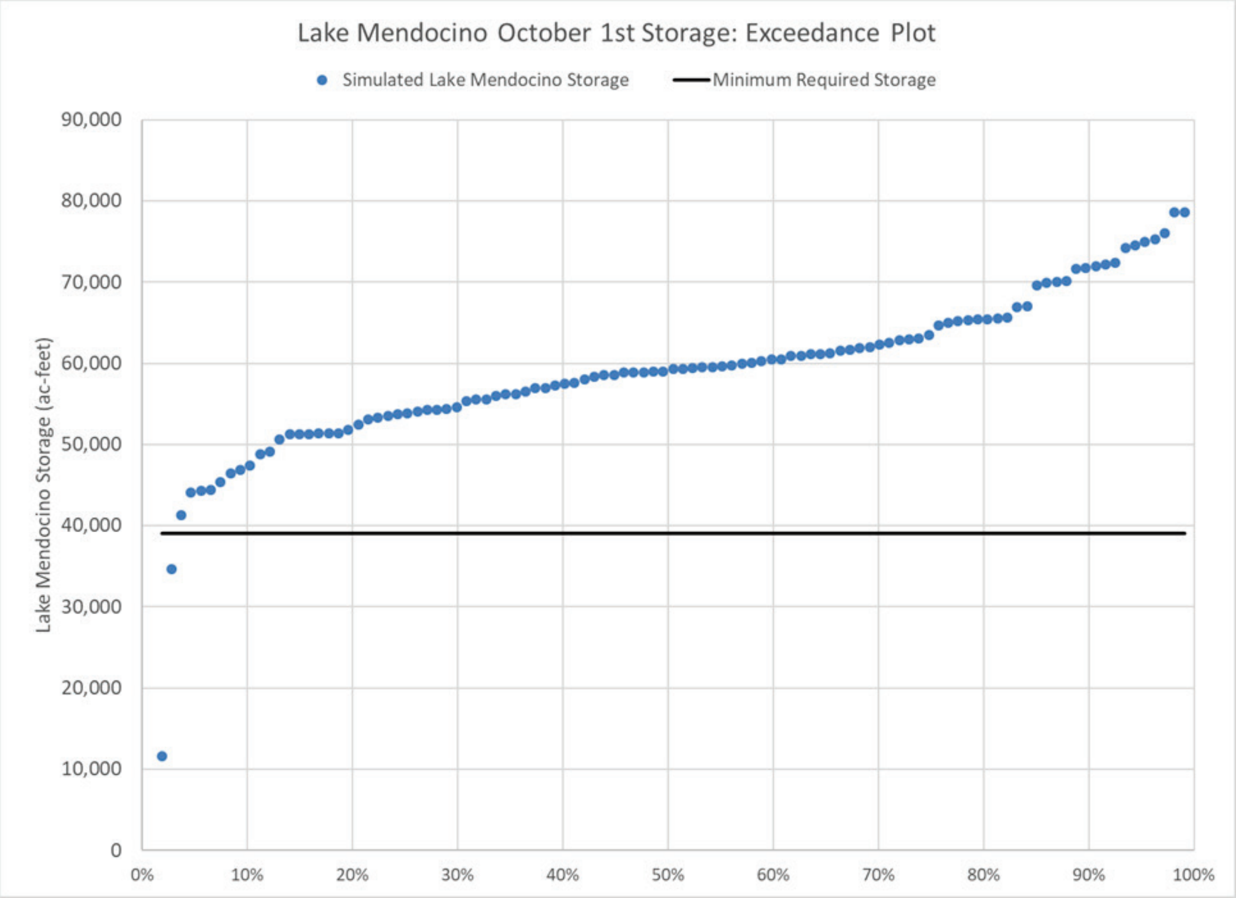


Figure 4: Lake Mendocino Storage Thresholds

Storage Thresholds and Evaluation Dates for Proposed Hydrologic Index (ac-ft)

	1/1	2/1	3/1	3/16	4/1	4/16	5/1	5/16	6/1	10/1	11/1	12/1
Dry	*68,400*	*68,400*	*68,400*	*77,000*	*86,000*	*94,000*	*96,000*	*97,000*	*98,000*	*61,000*	*53,000*	*51,000*
Critical	*45,500*	*51,500*	*57,000*	*68,000*	*74,000*	*76,000*	*77,000*	*79,000*	*79,000*	*47,500*	*43,500*	*41,000*

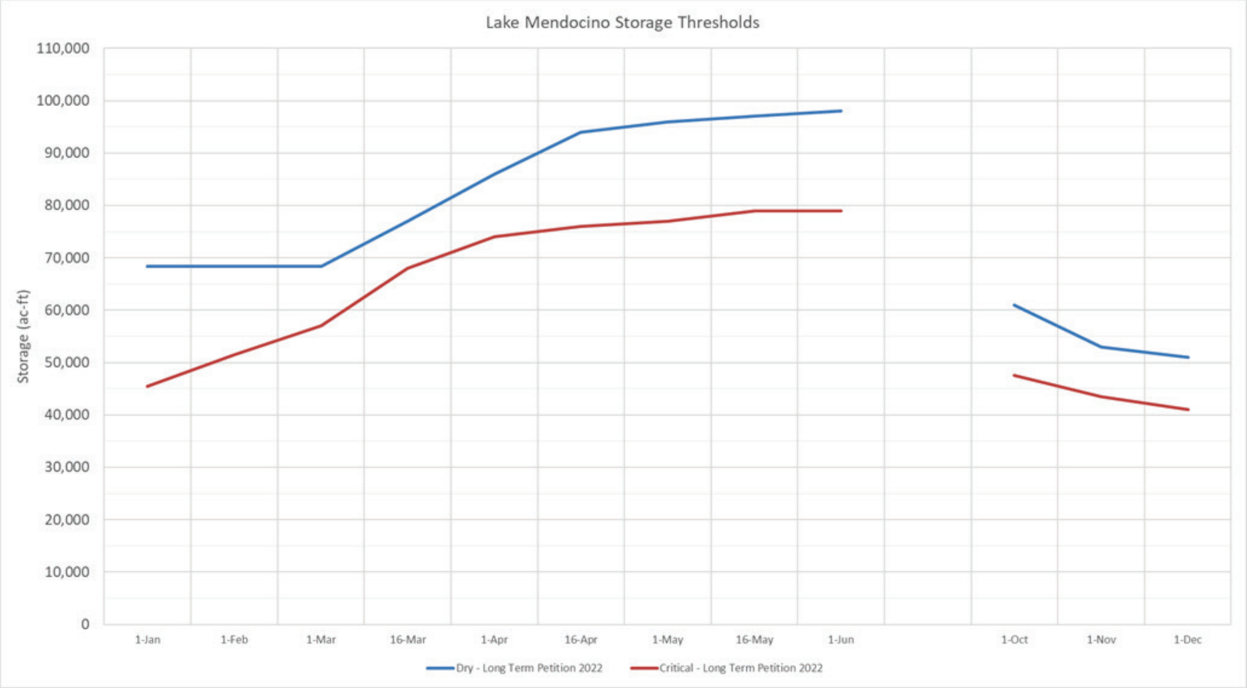


Figure 5: Percent Occurrence of Water Supply Conditions in Proposed Hydrologic Index

Water Supply Condition - Percent Occurrence			
Month	1	2	3
Jan	44%	48%	8%
Feb	71%	21%	8%
Mar	87%	7%	6%
Apr	59%	33%	8%
May	39%	51%	10%
Jun	32%	54%	14%
Jul	32%	54%	14%
Aug	32%	54%	14%
Sep	32%	54%	14%
Oct	37%	54%	9%
Nov	55%	37%	8%
Dec	50%	43%	7%
Average	**47%**	**43%**	**10%**