Endangered Species Act
Section 7 Consultation

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

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Table of Acronyms

Ac-ft	acre-feet
BA	Biological Assessment
CDFG	California Dept. Fish & Game
CESA	California Endangered Species Act
CHART	Critical Habitat Analytical Review Team
CIE	Center for Independent Experts
Corps	U.S. Army Corps of Engineers
CVD	Coyote Valley Dam
CVFF	Coyote Valley Fish Facility
D1610	SWRCB Water Right Decision 1610
DCFH	Don Clausen Fish Hatchery
DPS	Distinct Population Segment
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
EWSL	Emergency water supply line
FMEP	Fishery Management & Evaluation Plan
HGMP	Hatchery and Genetic Management Plan
LMHPP	Lake Mendocino Hydroelectric Power Plant
LWD	Large woody debris
MCRRFCD	Mendocino County Russian River Flood Control and Water Conservation Improvement District
MOU	Memorandum Of Understanding
NCPA	Northern California Power Agency- (member: *City of Ukiah*)
NCRWQCB	North Coast Regional Water Quality Control Board
NMFS	National Marine Fisheries Service
PCE	Primary Constituent Element (*of critical habitat*)
ppm	parts per million
ppt	parts per thousand
RCD	Resource Conservation District
RPA	Reasonable and Prudent Alternative
RRCSCBP	Russian River Coho Salmon Captive Broodstock Program
SCWA	Sonoma County Water Agency
SWRCB	State Water Resources Control Board
TRT	Technical Recovery Team (*for listed species Recovery Plans*)
VSP	Viable Salmon Population
WSD	Warm Springs Dam
WWTP	Wastewater Treatment Plants
YOY	Young-of-Year (*i.e.*, age 0+ fish)

EXECUTIVE SUMMARY

Pursuant to Section 7(a)(2) of the Federal Endangered Species Act (ESA), NOAA's National Marine Fisheries Service (NMFS) consulted with the U.S. Army Corps of Engineers (Corps) regarding its operations of Warm Springs Dam (WSD) and Coyote Valley Dam (CVD) and a suite of activities that are authorized by the Corps and undertaken by the Sonoma County Water Agency (SCWA) and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD). The Corps, the SCWA, and the MCRRFCD have proposed to implement, for an additional 15 years, ongoing practices and operations at WSD and CVD and activities related to flood control, water diversion and storage, regulation of flows in the Russian River and Dry Creek, estuary management, hydroelectric power generation, channel maintenance, and fish hatchery production.

These actions likely affect Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*), CCC coho salmon (*O. kisutch*), and California Coastal (CC) Chinook salmon (*O. tshawytscha*), each of which is protected as threatened or endangered under the ESA. The proposed actions also likely affect designated critical habitat for these species. The purpose of this consultation is to provide a determination regarding whether the Corps has insured that the proposed project is not likely to jeopardize one or more of these species or destroy or adversely modify their designated critical habitat. If a project is found to jeopardize a species or adversely modify its critical habitat, NMFS must develop a Reasonable and Prudent Alternative (RPA) to the proposed project in coordination with the federal action agency and any applicant. If the project is also expected to result in the incidental take of listed species, NMFS must also provide reasonable and prudent measures (RPM's) to minimize and monitor the impact of the incidental take of listed species.

In this document, we present our analysis and conclusions in the conventional format for biological opinions as described in the Endangered Species Consultation Handbook (U.S. Fish and Wildlife Service and NMFS 1998). This biological opinion includes reviews of the *Consultation History*, a *Description of the Proposed Action*, the *Status of the Species and Critical Habitat*, and the *Environmental Baseline*. Following those reviews we provide an analysis of the *Effects of the Proposed Action*, *Cumulative Effects*, and an *Integration and Synthesis* section in which we analyze the effects of the project in the context of the species status and environmental baseline. This biological opinion concludes with NMFS' determination regarding the impacts of this proposed project on the species' likelihood of survival and recovery, and on the value of the species' critical habitat. Because we have determined that this proposed project is likely to jeopardize the continued existence of some of the salmonid species affected by the proposed project, and adversely modify their critical habitats, we have provided a *Reasonable and Prudent Alternative* (RPA) to the proposed action that 1) avoids jeopardy to the species and adverse modification of critical habitat, 2) can be implemented in a manner consistent with the intended purpose of the action, 3) is economically and technically feasible, and 4) is within the legal authorities of the Corps, SCWA, and MCRRFCD.

The Proposed Action

NMFS analyzed the effects of continued operation of the Russian River Water Supply and Flood Control Project (Project) for a 15 year period on ESA-listed threatened and endangered salmonid species within the Russian River watershed. The Project includes operation of two dams and appurtenant facilities in the Russian River watershed. Together, these facilities are operated to control flooding within the watershed, to supply water to users within and outside the watershed, and to generate hydroelectric power. The altered flow regimes caused by the Project change the natural hydrology of the Russian River estuary, and artificial breaching of a barrier beach at the mouth of the river is often required to prevent flooding adjacent to the estuary. In addition, the Project includes channel maintenance activities that keep the water delivery system functional and reduce the impacts of flooding in the mainstem and some tributaries of the Russian River. The Project also includes operation of two fish hatchery facilities, the Don Clausen Fish Hatchery (DCFH) located at WSD and the Coyote Valley Fish Facility (CVFF) at CVD. SCWA's scope of maintenance responsibilities covered under this Biological Opinion includes maintenance of stream channels and small reservoirs throughout most of an area that SCWA terms Zone 1A, which consists of the Laguna de Santa Rosa watershed, as well as maintenance activities on the Russian River main stem and the segment of Dry Creek downstream from WSD. The Corps' maintenance activities include safety inspections at the two dams. In addition, MCRRFCD conducts channel maintenance activities related to the CVD in the Mendocino County portion of the Russian River. Channel maintenance by both counties is related to Federal sites and inspection of levees under Public Law 84-99 (non Federal sites), but this consultation does not include implementation of the current Corps Operations and Maintenance manual for channel maintenance in the Russian River watershed. Instead, NMFS is consulting on channel maintenance practices as described in Section III.B and referenced to the Corps and SCWA's Biological Assessment where appropriate.

In the initial draft of this Biological Opinion, dated July 11, 2007, NMFS analyzed the implementation of ongoing project operations for ten years, because SCWA and the Corps were contemplating potential complex, future changes in project flow release schedules associated with new water rights and other avenues for increasing reservoir water supplies. Such changes were likely to take at least ten years to accomplish. We were unable to fully analyze both short-term ongoing and future water supply scenarios because of the uncertainties and limited available information about those future scenarios. Originally, the Corps, SCWA, and NMFS agreed that it was prudent to evaluate project effects for the next ten year period because future changes in water supply operations contemplated by SCWA would likely take ten years to fully analyze and develop the permits and water rights agreements/decisions that may yield additional water rights and water supply that would affect flows and habitat in the Russian River and Dry Creek.

During work on the RPA, the Corps, SCWA, 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 the Corps and SCWA on August 1, 2008, and indicated that the timeframe for analysis of the original proposed project would need to be changed from ten years to fifteen years (NMFS 2008b). 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, the Corps, and SCWA agreed to amend the period of the proposed project from ten to fifteen years (Russian River Project Executive Committee Meeting August 4, 2008). The RPA's approaches to addressing impacts to critical habitat were also discussed between SCWA and NMFS and modified subsequent to the August 1, 2008 working draft.

The water supply and flood control elements of the Project involve the regulation of flood flows to control flooding in properties adjacent to the Russian River, and the storage of water in two reservoirs to be released for water supply in Sonoma, Mendocino, and Marin counties during the spring, summer, and fall. The water supply is released from the reservoirs and flows down the main stem Russian River and Dry Creek to diversion points downstream of the dams. Part of the water stays in the river channel and flows to the Pacific Ocean at the river's mouth near Jenner. The diverted water is delivered to end-users for municipal, industrial, agricultural, and domestic uses.

The keystone elements of the project are CVD, on the East Branch headwaters of the Russian River, and WSD on Dry Creek, a main tributary of the Russian. Russian River water is released from Lake Mendocino (the reservoir formed by CVD) for flood control, and, under the requirements of the State Water Resources Control Board's (SWRCB) Decision 1610 (D1610) for water supply. The Coyote Valley Fish Facility (CVFF) was constructed in 1992 at the base of CVD to mitigate for the loss of salmonid habitat and natural salmonid production upstream of CVD. Water released from Lake Sonoma (the reservoir formed by the WSD) is also released for flood control and water supply. The Don Clausen Fish Hatchery (DCFH) was built at the base of WSD to mitigate for the loss of fish habitat and anadromous salmonid production in the upper Dry Creek watershed. The operation and programmatic purpose of the hatchery has changed to a more adaptive program since its inception. There have been operational changes towards salmonid conservation and recovery to further mitigation goals and to fulfill the Corps' obligation under Section 7 (a)(1) of the ESA. D1610 establishes minimum flow requirements for both Dry Creek and the Russian River. Minimum stream flows under D1610 are specified for four different reaches in the Russian River watershed, assuring high enough summer flows to meet the diversion requirements as well as river-based recreational uses.

In addition to the two major dams in the Russian River watershed, there are several small storage reservoirs, levees, temporary dams, and other elements of the system that contribute to accomplishing the water supply and flood control goals of the Project and are discussed in subsequent sections of this consultation.

Status of the Species and Critical Habitat

In this opinion, NMFS assessed the condition of each of the three listed salmonid species relative to their extinction risk; we also describe the function and role of their respective critical habitats for species conservation. The CCC coho salmon includes coastal populations in rivers entering the ocean along the coasts of Mendocino, Sonoma, Marin, San Mateo and Santa Cruz counties.

The CCC steelhead includes populations ranging from those in the Russian River south to streams in Santa Cruz County, plus populations in streams entering San Francisco Bay (*e.g.*, Sonoma Creek, Napa River, Alameda Creek). CC Chinook salmon include populations of this species in coastal streams ranging from the Russian River north to Humboldt County's Redwood Creek. Our assessment of the status of these species examined the viability (per the framework described by McElhany *et al.* 2000) of populations in four to five distinct geographic areas (termed diversity strata) that constitute each species. For this, we used the diversity strata identified by Spence *et al*. (2008).

Our assessment of extinction risk focuses on the viability of individual populations in each diversity strata in order to appropriately apply the ESU viability criteria provided by Spence *et al*. (2008), which is the current definitive source for ESU viability evaluation. Spence *et al*. (2008) report that for an ESU or DPS to be viable, "representative", "redundancy", and "connectivity" criteria must be met.

CCC coho salmon, which is listed as Endangered, faces the highest risk of extinction of the three salmonid species considered in this opinion. This is evidenced by their precipitous decline in abundance during the last several decades and poor status of population viability metrics (abundance, population growth rates, spatial structure, and genetic diversity). Wild populations of this species were extirpated in the nearby Salmon and Walker Creek watersheds; their distribution has been very highly reduced in the Gualala watershed. The cause of this decline is likely the widespread degradation of habitat, particularly those habitat attributes that support freshwater rearing life stages. The loss of this habitat and the concurrent extirpation of local populations have resulted in a high degree of isolation for the remaining populations.

CCC steelhead is listed as a Threatened Species. Its habitat is degraded throughout the Distinct Population Segment, especially in the two diversity strata with streams bordering San Francisco Bay. However, the diverse life-history strategies of steelhead have helped reduce this species' extinction risk overall. For example, the highly variable time of instream residence (one year to several years) and spawning age allow for effective temporal dispersal within a population. Also individuals within this species are able to spawn in multiple years, unlike coho and Chinook salmon which die shortly after spawning. CCC steelhead appears to be doing best in the more coastal environments and seems more challenged, but persistent in the more inland and urbanized areas. The overall extinction risk of this species is moderate.

The extinction risk for CC Chinook salmon, which is listed as a Threatened Species, is likely intermediate between that of CCC coho salmon and CCC steelhead. Their habitat condition is somewhat better than for the other species mainly because their range lies well north of San Francisco Bay and they do not occupy rearing habitats throughout the summer when stream flows can be very low or negligible. However, habitat degradation is still widespread and is particularly an issue in the upper Eel River. Excluding the reduced returns in 2007, the resurgence in abundance in the Russian River and in other southerly watersheds of this ESU suggests favorable conditions not entirely explained by freshwater habitat analysis. In any case, the more restricted life-history strategy compared to steelhead, relative spatial isolation of the Russian River population, and habitat condition in the Eel River make the extinction risk for CCC Chinook salmon higher than for CCC steelhead.

Environmental Baseline

The environmental baseline section provides the reference point for the listed species and their habitats within the action area to which NMFS adds the effects of the proposed action. The action area includes the Russian River and its tributaries downstream of WSD and CVD. This large action area is necessary because of the need to address the impacts of straying hatchery fish in the watershed. However apart from that issue, our effects analysis was primarily focused on: 1) the East Branch Russian River below CVD and the main stem Russian River from the confluence of the East Branch to the river's mouth at Jenner, 2) Dry Creek downstream of WSD, and 3) areas of the Mark West Creek watershed that do not contain coho salmon, including Santa Rosa Creek and its tributaries, and the Laguna de Santa Rosa. Because channel maintenance activities in Zone 1A and other project actions were not proposed for portions of the Mark West Creek watershed upstream of its largest tributary the Laguna de Santa Rosa, it was unnecessary to focus on that portion of Zone 1A.

The 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 Projects that have already undergone consultation under Section 7 of the ESA, and the impact of State or private actions which are contemporaneous with the consultation process. By establishing the historical and current condition of the species and their habitat in the action area, we describe those conditions to which the effects of the project under consultation are added in our analysis of the project. Our ability to understand factors contributing to the baseline condition is also important for predicting future baseline conditions and likely responses of salmonids to the effects of the proposed action.

Urban, residential, and agricultural developments, timber harvest, road construction, water supply and flood control management activities have had a collective adverse effect on the quality and quantity of spawning, rearing, and migratory habitats for steelhead, coho salmon, and Chinook salmon in the Russian River watershed. Prior to the construction in 1908 of the Potter Valley Hydroelectric Project, which conveys water from the upper Eel River to the upper Russian River, late summer flows in the Russian River were in the vicinity of 20 to 30 cfs. Now with that project, the construction of Scott Dam on the Eel River, CVD, and WSD, the Russian River sustains flows over 185 cfs throughout much of the mainstem and at least 125 cfs flows to the ocean in most summers. Prior to these projects, the river's estuary likely closed during summer months with a barrier beach that formed a large freshwater lagoon providing high quality rearing habitat for steelhead and coho salmon.

Prior to European settlement, the mainstem Russian River was a dynamic meandering river which migrated across its floodplain creating ox-bows and side sloughs. Most of the 110 miles of mainstem and many hundreds of more miles in the tributaries were likely historically available to salmonids for spawning and juvenile rearing (SEC 1996). Both the mainstem and tributaries very likely had an abundance of large woody debris in the form of root wads and fallen logs that created scour pools and provided cover and foraging sites for rearing salmonids (SEC 1996). Summer flows were much lower in the mainstem; however, numerous deep pools likely stratified and contained lower cooler layers. Stream channelization, road construction along stream

margins, bank stabilization, and water diversions in tributaries have significantly degraded stream habitats throughout the watershed by simplifying stream channels, isolating them from their flood plains, greatly increasing sedimentation, blocking fish migrations, and reducing or eliminating flow and cover.

Effects of the Proposed Action

Listed salmonids are adversely affected by operations for flood control at the two project dams, by project flow releases for water supply, by the management of estuary water levels, by the project related hatchery operations, and by channel maintenance activities in both the mainstem and Russian River tributaries. We did not find significant impacts specific to the operations of the small hydroelectric facilities at CVD and WSD.

Flood control releases at CVD have increased the duration of high flows that scour stream substrates and salmonid spawning habitats in the segment of the mainstem Russian River immediately downstream of the East Branch. In addition, the project's proposed rates of flow ramp down of 250 cfs/hr (when flows are 250-1000 cfs) and 1000 cfs/hr (when flows exceed 1000 cfs) likely cause both CC Chinook salmon and CCC steelhead fry and juveniles to be stranded in isolated pools or beached in dewatered areas. The stranded fry and juveniles are likely to experience higher rates of predation. Some fry and juveniles are likely to be stranded in disconnected pool areas that may not become reconnected depending on flow regime, resulting in the death of these fish. Pre-flood and five-year periodic inspections at CVD, which are conducted during late summer, adversely affect juvenile steelhead because the Corps shuts off stream flow at CVD for about two hours with resulting loss of salmonid rearing habitat in the East Branch and stranding of juvenile steelhead in the remaining isolated pools. CVD is also known to release highly turbid water for extended periods well after turbidity levels have diminished upstream of the mainstem's confluence with the East Branch and elsewhere in the river's unregulated tributaries.

Flood operations at WSD likely cause minor scouring of spawning habitat in Dry Creek in the three mile segment immediately below the dam. We estimate that 5 to 10% of the salmonid redds constructed in this segment are likely to be scoured (*i.e.*, lost) when WSD releases are 5000 cfs or greater. The proposed rates of ramp down for WSD flood control operations, which are the same as above for CVD, are expected to cause stranding of fry and juvenile salmon and steelhead in the three mile segment immediately below the dam. However, the steep banks and lack of side channels in this segment are generally not conducive to high stranding rates. The continuous 25 cfs minimum bypass flow at WSD will likely avoid stranding and beaching of juvenile steelhead or coho salmon during annual pre-flood and five-year periodic inspections.

Flood control operations at the dams will affect stream flows in Dry Creek and the main stem during and shortly after heavy precipitation and runoff in winter or early spring. These operations limit peak flows by storing water in the reservoirs, after which the Corps releases those waters downstream during an extended period when flood risk has abated.

During winter and early spring, the dams generally have a relatively modest influence on stream flow in the Russian River and Dry Creek because of the substantial, unregulated inflow from numerous tributaries. However, during the low flow season (approximately late May through October) releases from WSD and CVD for water supply significantly affect stream flow and available rearing habitat for steelhead and coho salmon, which rear in freshwater habitats throughout the summer months. The project's proposed flow management at WSD and CVD during late spring, summer, and fall has a clear adverse effect on the availability of rearing habitat for steelhead in the14.1 mile segment of Dry Creek, in 34 miles of the upper Russian River, and in the river's estuary. The project's proposed flow management also adversely affects the quality and quantity of rearing habitat and survival of juvenile coho salmon in Dry Creek. Although the upper main stem Russian River and Dry Creek support good quality spawning habitat for listed salmonid species, salmonid fry that emerge from the gravels of Dry Creek and the upper Russian River will encounter limited suitable quality rearing habitats because much of the stream areas have excessive current velocities. This will lead to increased mortality of juvenile steelhead and coho salmon. The proposed flow regime will also affect the survival of juvenile salmonids that emigrate downstream from tributaries into Dry Creek or the upper Russian River. Juvenile Chinook salmon rear in freshwater only until late spring or early summer when they then enter the ocean environment. For that reason, regulation of late spring and summer flows has much less effect on rearing juvenile Chinook than the other two species.

Proposed project operations will likely have significant adverse effects on the Russian River's estuarine rearing habitat for each salmonid species. The proposed project will sustain high, artificial inflows to the estuary during the low flow season and it will entail detrimental sandbar breaching activities at the mouth that will significantly affect water quality in the lowermost segment of the river. The artificial breaching creates a near marine environment, with shallow depths and high salinity throughout most of the water column; in some areas salinity stratification contributes to low dissolved oxygen at the bottom. The combination of artificially high flows entering the estuary during summer months and the proposed plan for breaching the estuary mouth is likely to result in the loss of productive rearing habitat for small juvenile salmonids at the mouth of the Russian River. This habitat is lost because the Russian River estuary will not remain closed long enough to form a freshwater lagoon during the low flow season in most years. This degradation of estuarine habitat will contribute to reduced survival of juvenile salmonids that emigrate to the estuary.

SCWA and MCRRFCD propose to continue bank protection, including repair or replacement of riprap, gravel bar grading, and vegetation maintenance on the main stem Russian River. Over the course of the 15 year project, no more than 30,000 lineal feet of the Russian River will be affected by channel maintenance activities. This represents about 6% of the entire Russian River mainstem. Each county may work as much as 2000 feet of main stem channel per year, but neither county may work on more than 15,000 feet of channel over the course of the 15 year project. Sonoma County will also conduct channel maintenance within constructed flood control channels and portions of natural waterways within Zone 1A (largely the Laguna de Santa Rosa and Santa Rosa Creek watersheds). We conclude that channel maintenance in the Russian River mainstem and Zone 1A will not appreciably degrade the value of critical habitat for listed salmonid species. However, we estimate numbers of juvenile steelhead that will likely perish

each year due to this maintenance activity. We also find that anticipated erosion control practices along the banks of Dry Creek are likely to degrade rearing habitats for salmonids.

The Corps' fish hatchery operations are required as mitigation for the loss of wild salmon and steelhead production due to construction of WSD and CVD. The hatchery program is currently operated to rear and stock coho salmon and steelhead trout. The DCFH coho salmon mitigation and enhancement program began in 1980; however, coho production at the facility was stopped entirely in 1996, after failing to meet mitigation goals. In 2001, the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) was initiated at DCFH to prevent extirpation of coho salmon in the Russian River basin, preserve genetic, ecological, and behavioral attributes of Russian River coho salmon while minimizing potential effects to other stocks and species, and to reestablish self-sustaining runs of coho salmon in tributary streams within the Russian River basin.

The RRCSCBP involves the collection of wild, juvenile coho salmon from Russian River tributaries. The wild juveniles are reared to reproductive maturity and then artificially spawned according to a genetic spawning matrix to maximize genetic diversity and avoid inbreeding. Juvenile coho salmon produced from the captive broodstock are then released into several Russian River tributaries as fry, where they rear, over-winter, migrate to the ocean, and then return as adults to spawn naturally in the streams. Each year since 2001, the program has reared and stocked coho salmon with lineage to wild juvenile coho salmon collected in Russian River tributaries. The RRCSCBP also includes an evaluation component, in which the survival of stocked juvenile coho salmon and the subsequent adult returns to tributary streams are monitored. At present, the genetics management and evaluation components (field monitoring) of this program do not have long term funding commitments.

The proposed continuation of the captive broodstock program will have objectives and methods similar to the existing RRCSCBP. The RRCSCBP is currently authorized under an ESA section 10(a)(1)(A) enhancement permit issued to CDFG, which acts as a contractor to the Corps for this hatchery requirement. Since the effects of the RRCSCBP have already been evaluated and covered by a permit, this program is not evaluated as part of the proposed action in this biological opinion, but it is included in the Environmental Baseline of this biological opinion. The lack of committed funding for the annual genetics management and field monitoring for the program threatens the viability of this program. The lack of an emergency water supply line to the DCFH also poses a significant threat to the RRCSCBP.

The steelhead hatchery program was not previously authorized under the ESA. That program involves the spawning of several hundred adults, the rearing of fry and juveniles, and the annual stocking of a combined total of about 500,000 steelhead smolts into Dry Creek and the upper Russian River. Recent genetic information on Russian River steelhead indicates that there are no substantial genetic differences between wild and hatchery propagated steelhead in the basin. Continued exclusion of wild steelhead from hatchery spawning stock could result in a divergent hatchery population with reduced genetic diversity and increased inbreeding. The stocking of hatchery smolts may have some adverse effects to wild populations through their predation or competition with wild fish. However, we believe those effects are relatively minor, because hatchery fish are stocked only into Dry Creek and the East Branch (near the confluence with the

upper main stem Russian River) when they are in a migratory stage and not acclimated to survival in the wild, and most migrate within a few weeks to the ocean. The hatchery program also promotes a fishery for marked adult hatchery fish in the mainstem Russian River; that fishery results in the capture (with barbless hooks) and release of wild steelhead, coho salmon, and Chinook salmon.

The principal effect of the water diversion facility at Mirabel Wohler is the loss of juvenile salmonids that may become entrained through or impinged on the water intake screens. Some minor loss of salmonids may also be caused by higher rates of predation from fishes (*e.g.*, pike minnow, smallmouth bass) in the Wohler impoundment or from stranding when the inflatable dam is inflated or deflated.

Integration and Synthesis

Project Effects on Critical Habitat

Because adult fall run CC Chinook salmon primarily migrate to spawning habitats during mid to late fall and the resulting progeny migrate downstream to the ocean during the following spring, flow management at WSD and CVD does not have significant adverse consequences for this species. Migrations of adult Chinook salmon appear to actually benefit from the elevated regulated flows during fall months, and rearing juveniles do not contend with the artificially high summer flows that limit available rearing habitat for the other Federally listed salmonid species. Although channel maintenance activities will likely have some adverse effect on spawning and rearing habitats for Chinook salmon, these effects will probably be minor because each year, channel maintenance will affect only a small portion (less than 1 mile) of the 94 mile long main stem Russian River. This 94 mile segment effectively supports rearing habitat for juvenile Chinook salmon along its entire length and spawning habitat at riffles along the approximately 58 mile segment upstream from Healdsburg. Ongoing channel maintenance activities in Dry Creek will likely diminish available rearing habitat for Chinook salmon; however, the extent of habitat loss for rearing Chinook salmon in Dry Creek due to ongoing channel maintenance activities is likely minor given the availability of rearing habitat for this species throughout the main stem Russian River. We conclude that, if the proposed project is implemented, critical habitat for Chinook salmon would remain functional to serve the intended conservation role for this species.

In contrast to the findings for Chinook salmon, the proposed project will likely have significant adverse effects on the critical habitat of steelhead and coho salmon. Because of these adverse effects, critical habitat for steelhead and coho salmon would not be functional to serve the intended conservation role for these species. Proposed flow releases from WSD and CVD during the approximately six-month long, low flow season will create excessively high current velocities that will greatly limit the value of 14 miles of Dry Creek and 34 miles of the upper Russian River as rearing habitat for steelhead. Flow management at the project's reservoirs and breaching of the estuary's bar will also adversely affect the value of steelhead rearing habitat in and near the vicinity of the estuary. Flow releases from WSD during summer and fall months will be so high that available habitat for rearing juvenile coho in Dry Creek will be minimal. Proposed continued channel maintenance activities in Dry Creek will contribute to armoring the

stream banks, reducing velocity refuge areas for fishes during high flows, and simplifying stream channel morphology with potential degradation of both summer and winter rearing habitats for steelhead and coho salmon. The significance of these impacts to critical habitat for rearing steelhead and coho salmon becomes apparent when the status of critical habitat for these species is considered.

Our review of the status of populations of CCC steelhead in the Russian River indicate that freshwater rearing habitat is one of the two primary types of critical habitat that are most degraded. In the Russian River watershed and nearby watersheds, degradation of steelhead rearing habitat is due to channel modifications, chronic deposition of fine sediments, and intensive diversions of surface flow in tributaries. The restoration of viable populations of steelhead within these watersheds will depend upon the restoration of good quality freshwater rearing habitats, including ecologically diverse habitats such as freshwater lagoons and deep main stem habitats for older age 1+ and 2+ fish. The restoration of viable populations of Russian River steelhead would substantially improve the chances for the recovery of the CCC steelhead DPS. However, as proposed, the project's flow management plan (*i.e.*, conformance with D1610, water supply releases, and water elevation management in the estuary) will hamper efforts to recover this species by degrading and, in some cases, eliminating important freshwater habitats in the Russian River.

Likewise, the availability of rearing habitat for coho salmon has been greatly reduced in the Russian River watershed and elsewhere as the result of numerous developmental activities. Coho salmon require especially cold water in which to rear, and developmental activities have undoubtedly limited the availability of such coldwater habitats. As discussed in the Effects Section, approximately 13 miles of Dry Creek provide temperatures that sustain rearing coho salmon; however, high flow releases from WSD during summer and fall months greatly limit the value of the PCE of critical habitat for rearing coho salmon. The proposed project operations appreciably degrade the value of Dry Creek's critical habitat for CCC coho salmon. Successful recovery of this species will very likely require protection, restoration, and enhancement of existing rearing habitats for this species. Given that the Russian River is the largest watershed occupied by CCC coho salmon and that it is centrally located in this ESU, it is unlikely that the CCC coho can be recovered without a successful restoration of coho salmon habitat and runs in the Russian River.

Project Effects on Species Survival and Recovery

We conclude that the proposed project operations are not likely to appreciably reduce the likelihood of CC Chinook salmon survival and recovery in the Russian River. We conclude this because the project is unlikely to reduce the abundance of spawners, the growth rate, spatial structure, or genetic diversity of the Russian River population of Chinook salmon. We base this finding on the following facts: 1) the population has experienced a generally positive growth over the past ten years, 2) the project does not cause significant adverse effects to the species' habitat, 3) the project will maintain the same freshwater conditions that have supported the recent growth of the Chinook salmon population, and 4) the action does not impact the species in such a way as to make it more vulnerable to other factors and environmental variation that are outside the control of the action.

Unlike the situation for Chinook salmon, the proposed project will likely have substantial adverse effects on both the coho salmon population and several steelhead populations in the Russian River watershed. The proposed flow management plan for CVD and WSD, the water level management plan for the river's estuary, and the ongoing channel maintenance activities in Dry Creek substantially influence the abundance, growth rate, and spatial structure of populations of steelhead and coho salmon in the Russian River. As proposed, the flow management plan will perpetuate status quo flows that strongly influence habitat suitability while the steelhead populations in the watershed experience negative growth trends due to other diverse developmental activities throughout the watershed. Elevated inflows to the estuary, the upper mainstem, and Dry Creek during the low flow season, and channel maintenance activities will continue to suppress populations of steelhead in the basin and impair recovery processes; instead populations of steelhead will likely continue to decline through degradation of habitats stemming from status quo project operations and diverse non-project related activities. Given that the Russian River supports nine steelhead populations, including one functionally independent population and six potentially independent steelhead populations, and that the river's populations span two of the five diversity strata (*i.e.*, major groups of populations) within the CCC steelhead, the survival and recovery of this DPS will likely depend on successful efforts to increase the abundance, spatial structure, diversity, and growth rates of Russian River steelhead populations. Likewise, given the central location of the Russian River in the range of CCC coho and that the watershed represents a third of the ESU by area, the survival and recovery of CCC coho salmon will likely depend on a substantial positive trend in the growth rate and abundance of coho salmon in the Russian River. The coho population is appreciably affected by the continued loss of juvenile coho that are likely displaced from Dry Creek due to high summer flows that limit habitat availability and by the continued channel maintenance practices that prohibit natural channel processes that create suitable rearing habitats for the species.

Conclusions

After reviewing the best available scientific and commercial data, the current status of the species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the continued operations of CVD and WSD for a fifteen year period in a manner similar to recent historic practices together with SCWA's proposed ongoing water diversions from the Russian River and its proposed stream channel maintenance activities, estuary management, and hydroelectric project operations at CVD and WSD are not likely to jeopardize the continued existence of threatened CC Chinook Salmon. However, we find that the continued operations of CVD and WSD in a manner similar to recent historic practices together with proposed Dry Creek stream channel maintenance activities and estuary management are likely to jeopardize the continued existence of threatened CCC steelhead and endangered CCC coho salmon.

After reviewing the best available scientific and commercial data, the current status of the critical habitat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS biological opinion that the continued operations of CVD and WSD for a fifteen year period in a manner similar to recent historic practices together with

SCWA's proposed stream channel maintenance activities and estuary management are likely to adversely modify critical habitat for CCC coho salmon and CCC steelhead. It is NMFS opinion that the proposed project is not likely to adversely modify critical habitat for CC Chinook salmon.

Reasonable and Prudent Alternative

To avoid the likelihood of jeopardy to the species and adverse modification of critical habitat, NMFS has collaborated with the Corps and SCWA in developing a Reasonable and Prudent Alternative (RPA) for this project that is consistent with the intended purpose of the action, can be implemented consistent with the legal authority and jurisdictions of the Corps and SCWA, is economically and technologically feasible, and would avoid the likelihood of jeopardizing the continued existence of listed species or the destruction or adverse modification of critical habitat. This RPA involves implementation of the project as described in Section III of this biological opinion, with modifications and additional actions as described in Section X.A of this opinion. In summary, new or modified actions that will be part of the Russian River Water Supply and Flood Control Project will include:

1. SCWA will petition the SWRCB to change minimum bypass flows identified in D1610 for the mainstem Russian River and Dry Creek. SCWA will also complete all necessary environmental documentation and other activities within its jurisdiction to promote changes to D1610 minimum flow standards as identified in Section X.A.1
2. SCWA will collaborate with NMFS and modify their estuary water level management in order to reduce marine influence (*i.e.*, high salinity and tidal inflow) in the estuary and promote a higher water surface elevation in the estuary for purposes of enhancing the quality of rearing habitat for age 0+ and 1+ steelhead. A program of potential incremental steps is described to address this issue. These include 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). SCWA will monitor the response of water quality, invertebrate production, and salmonids in and near the estuary to water surface elevation management in the estuary-lagoon system.
3. The Corps and SCWA will implement and monitor on-the-ground enhancements of rearing habitat that will avoid adverse modification of critical habitat and appreciably increase the survival of juvenile salmonids in Dry Creek during both summer and winter months. To do this, SCWA will enhance the quality and quantity of pool habitat along the 14 mile segment of Dry Creek and install boulder clusters to improve rearing habitat for steelhead and coho salmon in Dry Creek. These enhancements, which will ameliorate habitat conditions adversely affected by high summer flow releases, will be distributed at several locations along Dry Creek and the timing of their installation will be staggered to begin by Year 5 and be completed by Year 12. Because the initial design, permitting, and construction of this work will take up to five years to complete, SCWA will also restore or otherwise enhance rearing habitat for salmonids in tributaries that enter Dry Creek downstream of WSD or other Russian River tributaries supporting coho salmon and steelhead by the end of Year 3 covered by this opinion. The Corps will assist the

SCWA in promoting enhancements of winter high flow refuge habitat for rearing coho and steelhead in Dry Creek.

4. SCWA will investigate the feasibility of constructing a pipeline to deliver water from Lake Sonoma to the mainstem of the Russian River in order to reduce the adverse effects of relatively high flow releases from WSD on rearing habitat for coho salmon and steelhead. An assessment of bypass pipeline alternatives will enable SCWA to identify the best method to ensure water deliveries while meeting salmonid habitat needs in Dry Creek in the unlikely event that habitat enhancement efforts in Dry Creek are unsuccessful in supporting successful growth and survival of juvenile steelhead and coho salmon.
5. The Corps will strengthen the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) by conducting needed 1) annual genetics analysis and 2) annual monitoring of the distribution and survival of stocked juvenile salmon and the subsequent return of adult coho to the Russian River.
6. SCWA will fund the implementation of an expansion of the RRCSCBP to include the annual rearing and stocking of 10,000 coho smolts genetically managed via the wild coho broodstock program.
7. The Corps will install a new back-up water supply pipeline to the Warm Springs Hatchery, and complete construction of additional rearing facilities for the coho salmon broodstock program.
8. Consistent with recent historic monitoring efforts, SCWA will annually monitor the upstream migration of adult salmonids at the Mirabel Dam between late August and late fall, and they will annually monitor downstream migration of juvenile salmonids past the Mirabel Dam during spring and early summer for 15 years.

Incidental Take Statement

This biological opinion provides an Incidental Take Statement for the taking of listed salmonids that is likely to occur due to the implementation of the proposed action and RPA for this project. Under the terms of section 7(b)(4) and section 7(o)(2), the identified incidental take is not considered to be prohibited taking under the ESA, provided that it is in compliance with the Terms and Conditions included with the incidental take statement.

Key terms and conditions include:

1. The Corps will initiate a study, complete a feasibility report, and then construct a low flow bypass pipe at the CVD by October 1, 2013.
2. The Corps will conduct a field study to investigate potential alternative ramp down criteria for flood control releases to try and minimize stranding downstream from CVD. The Corps will adjust ramping rates to minimize impacts to fisheries if they will allow flood control to be maintained.
3. The Corps will conduct studies to investigate the effects of CVD and WSD operations on turbidity in the Russian River. If turbidity from CVD or WSD is adversely affecting listed salmonids, the Corps shall complete and begin implementation of a plan to minimize and avoid these adverse effects by no later than 2014.

4. The Corps, SCWA, MCRRFCD or their designees shall ensure that relocation of salmonids from in-channel flood control work areas is accomplished by means that minimize harm and mortalities of listed salmonids.
5. SCWA shall complete design of the 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. Also within three years of the issuance of this opinion, SCWA shall decommission or modify the infiltration ponds on the East side of the Russian River at the Mirabel/Wohler facility to prevent fish entrapment in these ponds during flood events.
6. For the next fifteen years, the Corps will conduct genetic management and genetic assessment of the DCFF and CVFF steelhead programs.
7. SCWA shall undertake measures to ensure that injury and mortality to listed salmonids resulting from fish monitoring at Mirabel dam, in the estuary, and in Dry Creek are low.
8. SCWA will undertake measures to ensure that harm and mortality to listed salmonids from adaptive management of the sandbar at the mouth of the Russian River are low.

I. INTRODUCTION

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA), requires Federal agencies to insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of threatened or endangered species or destroy or adversely modify critical habitat. The section 7(a)(2) interagency consultation regulations define "jeopardize the continued existence of" as "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." The regulatory definition of critical habitat has been invalidated by Federal courts. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR §402.02. Instead, we have relied upon the statutory provisions of the ESA and the guidance provided by NOAA's Assistant Administrator for Fisheries to complete the following analysis with respect to critical habitat (NMFS 2005a).

NOAA's National Marine Fisheries Service (NMFS) is conducting a formal consultation for actions carried out by the US Army Corps of Engineers (Corps), and activities undertaken by the Sonoma County Water Agency (SCWA) and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD) that are authorized by the Corps. The Corps, the SCWA, and the MCRRFCD propose to operate and maintain Federal facilities and conduct activities related to flood control, water diversion and storage, instream flow releases, estuary management, hydroelectric power generation, channel maintenance, and fish hatchery production. The Corps owns and operates Warm Springs Dam (WSD) and Coyote Valley Dam (CVD). The Corps owns and the California Department of Fish and Game (CDFG) operates the Don Clausen Fish Hatchery (DCFH) at WSD and the Coyote Valley Fish Facility (CVFF) at CVD. Also, the Corps undertakes flood protection and authorizes stream stabilization activities of SCWA and MCRRFCD.

The actions proposed by the Corps, the SCWA, and MCRRFCD may adversely affect Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*), CCC coho salmon (*O. kisutch*), and California Coastal (CC) Chinook salmon (*O. tshawytscha*) protected as threatened or endangered under the ESA, and designated critical habitat; therefore, the proposed actions must undergo a formal consultation pursuant to section 7(a)(2) of the ESA. NMFS also considered potential impacts on the ESA listed Southern Resident Killer Whale (*Orcinus orca*) population due to their range, which includes the Pacific Ocean adjacent to the Russian River, and apparent dietary preference for Chinook salmon (NMFS 2008a).

As part of this consultation, the Corps, the SCWA, the MCRRFCD, and NMFS have entered into an MOU that sets a framework for the consultation on project activities that may directly or indirectly affect coho salmon, steelhead, and Chinook salmon in the Russian River. The MOU states that the parties will seek information and assistance from other local, state and Federal agencies, including the CDFG, the State Water Resources Control Board (SWRCB), the North Coast Regional Water Quality Control Board (NCRWQCB), the State Coastal Conservancy, and the Mendocino County Inland Water and Power Commission.

Our task in this consultation is to provide a determination regarding whether the Corps has insured the proposed federal action and interrelated and interdependent activities are not likely to jeopardize listed species or result in destruction or adverse modification of critical habitat over the next fifteen years. We are not consulting on possible future changes to operations based on increased water demands from anticipated human population growth or other changes to current operations, with the exception of a minor change to operation of the inflatable dam at Mirabel, and minor changes to some channel maintenance activities (see *Description of the Proposed Action*.)

A. Organization of the Biological Opinion

In this document, we present our analysis and conclusions in the conventional format for biological opinions as described in the Endangered Species Consultation Handbook (U.S. Fish and Wildlife Service and NMFS 1998). This biological opinion includes reviews of the *Consultation History*, a *Description of the Proposed Action*, the *Status of the Species and Critical Habitat*, and the *Environmental Baseline*. Following those reviews, we provide an analysis of the *Effects of the Proposed Action*, *the Cumulative Effects*, and an *Integration and Synthesis* section. This biological opinion concludes with NMFS' determination regarding the impacts of the proposed action on the function and role of critical habitat for species conservation, and on the species' likelihood of both survival and recovery. Because we have determined that the Corps has not insured the proposed action is not likely to jeopardize the continued existence of some of the salmonid species affected by the proposed project and not likely to adversely modify their critical habitat, we provide a *Reasonable and Prudent Alternative* (RPA) to the proposed action. The RPA does not eliminate all impacts to listed salmonids, and therefore, an *Incidental Take Statement* is also provided.

The *Status of the Species and Critical Habitat* section portrays the condition of the species and their habitats relative to the species probability of extinction by describing how the species is surviving given its life history strategy and the condition of its environment. The *Environmental Baseline* describes and analyzes the condition of the species and its habitat, including critical habitat, in the action area. The *Effects of the Proposed Action* section describes and analyzes the effects of the action on habitat, including critical habitat, the exposure of steelhead and salmon to these effects, and the expected response of salmon and steelhead, and critical habitat in the action area. Once the effects are described, we assess, in the *Integration and Synthesis*, the ramifications of these effects to critical habitat and listed species in the action area on the function and role of critical habitat for species conservation and the likelihood of both the survival and recovery of the species at the Evolutionarily Significant Unit (ESU) or Distinct Population Segment (DPS)[1] scale, given the *Status* of the ESU or DPS and the *Environmental*

[1] Historically, NMFS used the concept of ESUs to define "species" in its administration of the ESA for anadromous salmon populations. For purposes of conservation under the ESA, an ESU is a distinct population segment that is substantially reproductively isolated from other conspecific population units and represents an important component in the evolutionary legacy of the species (Waples 1991). However, NMFS recently delineated steelhead populations as distinct population segments (DPS) rather than ESUs (71 FR 834). A DPS is a group of organisms that are discrete from other populations and are significant to their taxon. A group of organisms is discrete if they are "markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors." Significance is measured with respect to the taxon (species or subspecies) as opposed to the full species (71 FR 834).

Baseline. Following this assessment, and based on our conclusions of jeopardy and adverse modification, we provide an RPA to the proposed project. The *Reasonable and Prudent Alternative* section describes the changes to the proposed project that are needed, and indicates how these changes avoid jeopardy and adverse modification and otherwise meet the regulatory requirements governing RPAs (50 CFR 402.02).

B. Uncertainty and Key Assumptions

The issues NMFS is obliged to address in this opinion are wide-ranging, complex, and often not directly referenced in scientific literature. We base many of our conclusions on explicit assumptions informed by the available evidence. By this, we mean to make a reasonable effort to compile the best scientific and commercial empirical evidence related to the analysis and to then apply general and specific information on salmonid biology from the published literature to make inferences and establish our conclusions.

In some cases, we have used the results of recent project specific studies or analyses conducted in the action area. For example, SCWA has studied water quality in the Russian River estuary before, during, and after estuary bar breaching for the last several years. In other situations, only more general local data are available on species presence or absence, and habitat condition. Where necessary, we have used this information and combined it with more general information from the scientific literature to infer salmonid response to the proposed project. In several instances, we make reasonable inferences that rely mainly on information in the scientific literature, because local data are not available.

For our analysis we searched for all existing literature pertaining to physical and biological dynamics of California estuaries and other estuaries with Mediterranean climates. We then subjected our analysis to an academic peer review described in the consultation history and requested references to any additional scientific reports that might elucidate the effects of current estuarine management activities on physical and biological conditions in the estuary. To address instream flow issues within Dry Creek and the mainstem Russian River, we requested that SCWA conduct a state of the art study involving the Instream Flow Incremental Methodology (Annear *et al.* 2004). As described in the Effects section VI.F, we ultimately agreed to examine habitat-flow relations using an intensive, quantitative Demonstration Flow Assessment (Annear *et al.* 2004; Railsback and Kadvany 2008).

Because we make reasoned inferences from the best available information, we do not address uncertainty in a rigorous quantitative sense in this biological opinion. For example, we assume that recent data on fish abundance in the action area is roughly accurate. We do not provide quantitative measures of uncertainty for these data such as error bars, confidence intervals, or standard deviations because: 1) in some cases the data available were obtained in a manner that does not allow for accurate quantification of these types of uncertainty, and 2) our use of this data does not require such precise measure of uncertainty. We often use fish abundance data to determine if relatively large or small numbers of listed salmonids are present in different portions of the action area. We assume that uncertainty in the data is not so great as to invalidate our relative comparisons of abundance. We support this assumption with information on the current

condition of habitat in which the species reside. We assume species abundance in areas with poor habitat conditions is likely to be low.

When we address uncertainty in our analyses, we apply that portion of section 7(a)(2) which dictates that action agencies are to "insure" that their actions are not likely to jeopardize the continued existence of listed species or adversely modify designated critical habitat. In other words, action agencies are charged with avoiding conclusions that there was no effect when, in fact, there was an effect.

The need to minimize the potential for this type of error results in providing the benefit of the doubt to the species. This approach is supported by the 1979 Congressional Record created when Congress amended the ESA to allow the Services to develop their biological opinions using the best information currently available or that can be developed during the consultation and concluded that the language "continues to give the benefit of the doubt to the species, and it would continue to place the burden on the action agency to demonstrate to the consulting agency that its action will not violate Section 7(a)(2)."[2]

In addition to the assumptions described above, NMFS relied on other key assumptions when assessing effects of the proposed action on listed salmonids and their critical habitat. Several assumptions are described elsewhere in this opinion; however, the following assumptions have considerable importance in our ability to analyze effects of the proposed action. If new information indicates an assumption is invalid, the Corps, SCWA, and NMFS may be required to re-assess effects of the proposed action on SONCC coho salmon and their critical habitat and reinitiation of consultation may be warranted.

1. Water Temperatures Limiting Steelhead Distribution in the Main Stem

Based on limited data, we assumed that water temperatures in the mainstem Russian River during July, August, and September are, in general, naturally too warm to support rearing juvenile steelhead between Cloverdale and the river's estuary (near the mouth of Austin Creek). We recognize that juvenile steelhead are occasionally seen in this segment, but we assume these are "dropdown fish" from tributaries and that coldwater refuges (*e.g.*, groundwater seeps) are few in number and that numbers of rearing juvenile steelhead in this segment are negligible during mid to late summer.

2. Russian River Estuary

Because local data on the Russian River estuary are limited, and historical data almost non-existent, we utilized data from other California estuaries and lagoons to help us evaluate the impacts of breaching the sand bar at the estuary's mouth. Our key assumption in this analysis is that with reduced inflow and without artificial breaching, in the spring and summer the estuary would likely naturally form a perched or closed lagoon that in many years would contain a highly productive environment for rearing juvenile steelhead (mostly freshwater, high food supplies, *etc*.). We assume that with current minimum flows, water levels can be managed to form a perched lagoon. Both of these assumptions are based on the documented formation of

[2] U.S House of Representatives Conference Report No. 697, 96th Congress, 2d Session 12. 1979.

perched or closed lagoons at river mouths on the coast of California, success in creating a perched lagoon via construction of an overflow channel across the bar at the mouth of the Carmel River, and other sources of information. Our reasoning is further described in the *Environmental Baseline, Effects of the Proposed Action, and Reasonable and Prudent Alternative.*

3. Global Climate Change

The acceptance of global climate change as a scientifically valid and anthropogenic driven phenomenon has been well established by the United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change, and others (Davies *et al.* 2001; Watson *et al.* 2001; Walther *et al*. 2002; UNFCCC 2006). The most relevant trend in global climate change is the warming of the atmosphere from increased greenhouse gas emissions. This warming is inseparably linked to the oceans, the biosphere, and the world's water cycle. Changes in the distribution and abundance of a wide array of biota confirm a warming trend is in progress, and that it has great potential to affect species' survival (Davies *et al.* 2001; Schneider and Root 2002). In general, as the magnitude of climate fluctuations increases, the population extinction rate also increases (Good *et al*. 2005). Global warming is likely to manifest itself differently in different regions. For example, in California, the California Energy Commission predicts an increase in the frequency of critically dry years (Cayan *et al.* 2006). Future climate change may therefore substantially increase risk to the species by exacerbating dry conditions.

In our analysis, the key assumptions we make about global climate change is that local impacts from this phenomenon, although ongoing, will be limited and difficult to predict during the next fifteen years. In general, natural climate variability within a ten year period is more prominent than the impacts of global warming (Cox and Stephenson 2007). While progress is being made on forecasting changes likely from climate change within the next ten years at global and large regional scales (Smith *et al.* 2007), predicting impacts on more local geographic areas in short time frames such as the fifteen years of this proposed project remain elusive.

Smith *et al.* (2007) predict that natural variability will partially offset the impacts of global climate change during the years 2005-2014. However, they predict the warming trend will continue, and at the global scale at least half of the years from 2010 to 2014 are likely to be warmer than 1998, one of the warmest years on record. Local impacts may not follow global trends. For example, a recent article in the Press Democrat reports the incidence of high temperatures in the Ukiah Valley (which includes a large portion of the mainstem Russian River) has decreased during the last 50 years, while the incidence of high temperatures in Napa Valley have increased (Press Democrat, August 4, 2008). This information suggests that climate change may actually be decreasing the incidence of high temperatures in the vicinity of the Russian River. Due to the absence of peer reviewed climate change models linking global temperature changes to the Russian River watershed, we cannot confidently project cooler temperatures in the Ukiah Valley forward for the next fifteen years. Based on the best available information, we cannot reliably predict if any water temperature increase (or decrease) will occur in the Russian River watershed during the next fifteen years due to global climate change.

In most instances in this biological opinion we used recent data (within the previous 10 to 15 years), to predict future stream flows, estuary bar breaching, and other conditions affected by the proposed project. We make the assumption that these data sets are representative of conditions likely to occur during the next fifteen years, because global climate change is unlikely to result in dramatic changes to local environmental conditions during this period. In addition, we assume any changes resulting from global climate change that have already occurred (such as the cooling in the Ukiah Valley) are captured by the previous 10 to 15 years of data we used and are reflected in current habitat conditions.

C. Ecological Conceptual Framework

As described above, the regulations implementing section 7(a)(2) of the ESA direct NMFS to assess proposed project impacts on species and critical habitat in order to determine whether the proposed project will not appreciably reduce the species' likelihood of survival and recovery or result in the destruction or adverse modification of critical habitat. In our biological opinions, NMFS conducts two separate but related analyses to make these determinations.

1. Critical Habitat

The basis of our critical habitat analysis is to evaluate whether the proposed project affects the function and role of the critical habitat for the conservation of the species. As a result, our analysis is organized around the structure of the habitat to be conserved. To do this, we use a hierarchical model that includes: 1) the primary constituent elements (PCEs) of critical habitat (spawning habitat, rearing habitat, freshwater migration corridors, *etc*.) and the habitat attributes that make up each PCE (such as spawning gravel quality or pool depth) for each salmonid life history stage, 2) the critical habitat within the stream reach or river, larger watershed areas, and whole watersheds, and 3) critical habitat in the geographic areas used by diversity strata[3] and then 4) the whole critical habitat designation.

The first step in our critical habitat analysis is to identify the PCEs of critical habitat in each ESU or DPS and diagnose their role in the conservation of each species and their current condition for supporting that role. We do this by identifying PCEs for each species based on guidance from critical habitat designations, and identifying the habitat attributes that make up each PCE for each salmonid life history stage. For example, we determined that the rearing PCE for CCC coho salmon is made up of the following habitat attributes: proximity to redds, complexity/cover, pool area and depth, water temperatures, and stream flows.

Once we diagnose the current condition of PCEs by diversity strata, we integrate this information to determine the current condition of critical habitat for supporting species conservation at the ESU or DPS level. We also identify the factors likely contributing to the current condition of critical habitat.

The next step is to analyze the current condition of PCEs in the action area for this proposed project. We did this by dividing the action area into four sub-areas: the Russian River

[3] Groups of populations of a species that inhabit areas with similar environmental and ecological background conditions. A more comprehensive definition is available in the Status of the Species section.

mainstem, Dry Creek, the Russian River Estuary, and Zone 1A (several Russian River tributaries where channel maintenance work will occur). We then describe the current conditions of PCEs in these areas and the factors likely contributing to those conditions. We also describe the relationship between important PCEs in the action area and the entire designated critical habitat with respect to the conservation of the listed species.

After determining the current condition of PCEs in the action area, we determine if these PCEs are likely to be affected by the proposed action and how any effects will influence the function of PCEs in the habitat units or areas affected. To do this, we use an exposure and response framework to identify what PCEs of critical habitat in the action area will likely experience as a result of the proposed action. We first identify the environmental "stressors" (physical, chemical, or biotic) directly or indirectly caused by the proposed action to which PCEs would be exposed. Next, we evaluate the likely response of PCEs to these stressors, based on the best available scientific and commercial information, and using an approach where severity increases along a continuum. For example, a project that releases water into the salmonid rearing PCE in an action area may increase water velocities within the PCE, potentially degrading the condition of the rearing habitat if high current velocities would hinder juveniles from feeding. If water velocities are high enough, juveniles may be prevented from feeding. If water velocities are higher still, the rearing habitat may become unusable because juveniles cannot swim against the current and would likely be swept downstream.

The proposed action has several complex components which may affect different PCE attributes in different areas, and information regarding the likely effects of some components is limited. Therefore, we used different approaches within our exposure and response framework to evaluate effects on different PCEs in the same area, and the same PCEs in different habitat areas. For example, we used the results of a Demonstration Flow Assessment conducted in 2001 to determine how the proposed project will impact the PCE of summer rearing habitat for juvenile coho salmon and steelhead in the mainstem of the Russian River and Dry Creek. In contrast, in Zone 1A, we used a process of qualitative identification of likely effects to the PCE of juvenile steelhead summer rearing habitat based on information from the scientific literature regarding the likely impacts of habitat simplification on salmonids.

Once we determine the effects of the proposed action on PCEs in the action area, we evaluate whether these impacts will affect the current ability of critical habitat to remain functional or retain its current ability for PCEs to be functionally established (NMFS 2005a). We did this by evaluating the project effects to PCEs in the action area when added to the environmental baseline and the importance of PCEs in the action area to the conservation of the species within the affected diversity starta and then the ESU or DPS. We did this with consideration of any cumulative effects to PCEs from future, non-federal actions that are reasonably certain to occur. If our assessment indicates that the action does affect critical habitat's ability to remain functional or establish functioning PCEs, or if we cannot determine that the action does not have that effect, we conclude that the action agency has not insured the action is not likely to result in the destruction or adverse modification of critical habitat.

2. Species

Similar to our critical habitat approach, we use a hierarchical conceptual model to evaluate project impacts on a species likelihood of survival and recovery. The model is based on a hierarchical organization of individual fish, population unit, diversity stratum (a group of populations), and the ESU or DPS (the species level group of diversity strata). The guiding principle behind this conceptual model is that the likelihood of survival and recovery of a species is dependent on the likelihood of survival and recovery of populations in each diversity strata that comprise that species; and the likelihood of survival and recovery of each population unit is dependent upon the fitness (growth, survival, or reproductive success) of the individuals that comprise that population.

Our use of this conceptual model incorporated the concept of Viable Salmonid Populations (VSP), which provides a framework for conducting Pacific salmonid risk assessments (McElhany *et al*. 2000). For Pacific Salmonids, viability is the state in which extinction risk of a population is negligible over 100 years and full evolutionary potential is retained (McElhany *et al*. 2000). We equate a species' "extinction risk" with the "likelihood of both the survival and recovery of the species" in the wild for purposes of conducting jeopardy analyses under section 7(a)(2) of the ESA. A species with a high extinction risk has a low likelihood of survival and recovery. A species with a low extinction risk has a high likelihood of survival and recovery. Our assessment focuses on whether a proposed action appreciably increases extinction risk[4], which is a surrogate for appreciable reductions in the likelihood of survival and recovery.

In our analysis, a viable salmonid population is an independent salmonid population that has negligible extinction risk and long-term persistence (over a 100 year time frame), which is consistent with recovery objectives. We begin our analysis by evaluating the current status of the species to diagnose how near, or far, the species is from this viable state. For that, we use the VSP framework and standard life history concepts. Four principal VSP parameters are used to evaluate the risk of extinction for the populations of salmonids affected by this proposed project: abundance, population growth rate (productivity), population spatial structure, and population diversity. These specific parameters are important to consider because they are predictors of population viability, and the parameters reflect general biological and ecological processes that are critical to the growth and survival of salmon populations (McElhany *et al*. 2000). Within this framework, NMFS considers the impacts of risk factors such as climate change and ocean conditions. Our analysis of species status concludes with our opinion as to the level of extinction risk the species faces. Similar to a species with a low likelihood of survival and recovery, a species with a high extinction risk does not equate to a species that does not have the potential to survive and recover. Instead, "high extinction risk" indicates that the species faces significant risks that can drive a species to extinction.. The results of the viability analysis serve as the current "benchmark" of species condition to which we add the impacts of the proposed project.

[4] We note that our use of extinction risk is generally non-quantitative. Spence *et al*. 2008 use a more quantitative definition for extinction risk that includes effective population size per generation and population viability analysis. Like Spence *et al*. 2008, we found we could not apply rigorous quantitative estimates of extinction risk to these species due to the limited data available.

To determine the impacts of the proposed project, we first examine the impacts of the project on the fitness of individuals in the action area, using the exposure and response framework described above to identify what individual salmonids will likely experience as a result of the proposed action. We first identify the environmental "stressors" (physical, chemical, or biotic) directly or indirectly caused by the proposed action to which salmonids would be exposed. Next, we evaluate the likely response of salmonids to these stressors, based on the best available scientific and commercial information, and using an approach where severity increases along a continuum. The ends of the continuum are bounded by no response at one end and death at the other. In between are such responses as startle, temporary cessation of feeding, minor injury, reduced growth, reduced reproductive success, *etc.* Importantly, we utilize the information from our critical habitat analysis on the current condition of PCEs in the action area, and the likely impacts of the proposed project on those PCEs, to help us determine what salmonids are exposed to, and how they are likely to respond.

Once fitness impacts on individuals are assessed, NMFS determines if these impacts are likely to affect the population(s) to which these individuals belong. For that, we use the VSP framework and standard life history concepts. Standard life history concepts are used to assess the impacts at a particular life history stage on the population's abundance, growth rate, distribution, and diversity (The VSP parameters discussed above). For example, if a proposed project results in the death of juvenile salmonids, NMFS will assess the impact of the amount of loss at this life history stage to the population's abundance, growth rate, distribution, and diversity. This analysis includes consideration of the condition of critical habitat used by the population.

We use the VSP population parameters (abundance, growth rate, spatial structure, and diversity), and Spence *et al.*'s 2008 ESU/DPS level criteria, as surrogates for numbers, reproduction, and distribution, the criteria found within the regulatory definition of jeopardy (50 CFR 402.02). For example, the first three VSP parameters are used as surrogates for numbers, reproduction, and distribution. We relate the fourth VSP parameter, diversity, to all three regulatory criteria. Numbers, reproduction, and distribution are all affected when genetic or life history variability is lost or constrained resulting in reduced population resilience to environmental variation at local or landscape-level scales. Similarly, Spence *et al.*'s (2008) ESU/DPS criteria address the viability of populations that make up an ESU or DPS via groups of populations called diversity strata. For example, ESU/DPS criteria for redundancy and connectivity assess whether or not the distribution of populations within diversity strata maintains connectivity (gene flow via straying) among populations within the strata and between that stratum and neighboring strata.

Consistent with our hierarchical approach, we determine if effects of the proposed action were likely to impact salmonid population numbers, growth rate, distribution, or diversity, and if any resultant changes to these parameters were likely to affect population extinction risk. We do this with consideration of the impacts of cumulative effects both in the action area and at the strata and ESU or DPS scales. If population extinction risk is likely to be increased, we assess whether this increase is likely to negatively affect ESU or DPS extinction risk by reducing the ability of the population's diversity stratum to support a viable ESU or DPS. If no increase in a population's extinction risk is expected, we conclude that the diversity stratum, and therefore the ESU or DPS, are not appreciably affected by the proposed action. Conversely, if we determine that a proposed project is likely to increase a population's extinction risk, or that we cannot

determine that the project is not increasing a population's extinction risk, we consider whether the risk of extinction of the ESU or DPS is likely to increase as a result. NMFS uses the ESU/DPS-level criteria (representation, redundancy, and connectivity) for the North-Central California Coast Recovery Domain provided by Spence *et al.* (2008) and described in the **Status of the Species and Critical Habitat** section of this biological opinion to determine if the population's extinction risk increase will increase the species' extinction risk. Our determination looks at the population's role in meeting the representation, redundancy, and connectivity criteria for the species and assesses the consequences of population extinction on the risk of extinction of the species.

II. CONSULTATION HISTORY

NMFS, the Corps, and the SCWA 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 ESA for existing operations and actions carried out by the Corps, SCWA, and the MCRRFCD. Existing actions to be covered in the Section 7 consultation are described in Section 3 of the MOU; they include CVD and WSD operations, hatchery operations, channel maintenance actions, water diversions, estuary management, channel maintenance in the Zone (1A) area of Santa Rosa and Rohnert Park, and water transmission within Sonoma County. The Corps, SCWA, and the MCRRFCD had been operating facilities for flood control, water supply and hydroelectric energy for many years before the three salmonid species in the Russian River were listed under the ESA. Starting with the listing of coho salmon in 1996 (61 FR 56138), the SCWA and the Corps engaged NMFS in preconsultation technical assistance to evaluate the potential risk to coho salmon from those operations and facilities.

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 CDFG. 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 fisheries 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 ESA, but it was included in the Russian River Section 7 consultation by the Executive Committee. Nineteen PPFC meetings were conducted between April 1998 and November 2004. Public comments were taken at these meetings and were considered by the Corps, and the SCWA during preparation of the Biological Assessment (BA).

The Executive Committee also established an Agency Working Group for the consultation, which included representatives from SCWA, the Corps, NMFS, CDFG, MCRRFCD, and the Regional Water Quality Control Board. The Agency Working Group met regularly to discuss the analyses for the BA for the consultation.

In 1999, SCWA contracted with Entrix Inc.(Entrix) to prepare the BA for the consultation, along with any necessary supporting documents. Entrix prepared an interim report for each of eight subject areas of the consultation describing existing facilities and operations and the resulting impacts to salmonids. The reports included:

Report Number	Report Topic	Report Date
Interim Report 1	Flood Control Operations	August 18, 2000
Interim Report 2	Fish Facility Operations	April 28, 2000
Interim Report 3	Flow-Related Habitat	April 5, 2002
Interim Report 4	Water Supply and Diversion Facilities	January 12, 2001
Interim Report 5	Channel Maintenance	May 11, 2001
Interim Report 6	Restoration and Conservation Actions	May 11, 2001
Interim Report 7	Hydroelectric Projects Operations	August 18, 2000
Interim Report 8	Russian River Estuary Management Plan	January 12, 2001

As part of the evaluation of existing operations, and as part of evaluating potential future alternatives, the Executive Committee approved a study of certain flow rates during the dry season. In September and October 2001, a flow-habitat study was conducted concurrent with flow reductions for the Corps's pre-flood inspections at CVD and WSD. A group of professional fisheries biologists from the represented agencies, as well as the consultant, Entrix, evaluated salmonid habitat at various locations of Dry Creek and the Russian River. Three flow release rates for each stream were evaluated by the team of biologists. A full discussion of the workscope history and results of the flow-habitat study is included in the Effects Section VI.F.1.

When all of the interim reports were complete, Entrix worked with representatives of the Agency Working Group to identify potential alternatives for facilities and operations that had been identified as having potential impacts for listed salmon species in the Russian River. When a range of alternatives was identified, two reports were prepared to describe alternatives and present recommendations for the alternatives that would be provided to the Executive Committee for consideration of modifying the project description. One report dealt with potential changes to minimum flow requirements in the main stem Russian River and Dry Creek (February 3, 2003), and the other report (September 13, 2002) dealt with all of the other subject areas.

Following completion of the Alternatives reports, Entrix, in concert with the Corps and SCWA, incorporated the recommended alternatives into the project description for the BA, and conducted an analysis of the impacts of the proposed actions (including proposed alternatives to reduce impacts) on listed fish species. On June 13, 2003, Entrix produced part 1 of the draft BA, which included the project description and status of the species. Entrix completed the full draft BA on January 16, 2004, and the final BA on September 29, 2004. As described in that BA, the proposed project would significantly change flow releases from WSD and CVD, including a low-flow proposal for the main stem Russian River with changes in minimum stream flows.

Following completion of the BA, the Executive Committee and the Agency Working Group continued to meet to discuss outstanding issues in the consultation (*e.g.*, the need for more data before requesting a change in the minimum flows required in the Russian River and Dry Creek

per SWRCB Decision 1610). NMFS provided comments on the BA to the Corps and SCWA on June 27, 2005, and requested additional information in certain areas. The SCWA and the Corps provided the additional information on July 5, 2006.

The parties to the Section 7 consultation discussed the need for obtaining more data before addressing potential changes in flow management on the main stem Russian River and Dry Creek. In the interest of ensuring ESA compliance for existing facilities and operations, NMFS agreed to prepare a biological opinion for existing facilities and operations (see Chapter 3 of the BA), with minor changes to operation of Mirabel Dam and channel maintenance, and including the hatchery programs, as specified in Chapter 4 of the BA and/or described below. On May 4, 2006, the Corps submitted a letter to NMFS requesting formal consultation and listing the facilities and operations to be included in the project description.

NMFS transmitted a draft biological opinion to the Corps and SCWA on June 11, 2007. The draft opinion indicated that the operation of the existing facilities were likely to jeopardize the species and adversely modify critical habitat for CCC coho salmon and CCC steelhead. NMFS did not provide any draft reasonable and prudent alternatives. Instead, NMFS invited the Corps and SCWA 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.

Subsequent to the issuance of the draft biological opinion, NMFS contacted the Center for Independent Experts (CIE)[5] to initiate outside peer review of the estuary analysis in the draft biological opinion. NMFS sought outside review because of the limited amount of peer reviewed scientific literature, commercial data, and other information available on salmonid use of California estuaries for rearing in the summer and fall.

NMFS received written comments from the Corps on September 14, 2007, and from SCWA on January 17, 2008. In October, November, and December of 2007, as well as January, February, and March of 2008, NMFS met with the Corps and/or SCWA to develop the components of a reasonable and prudent alternative (RPA) to the proposed project.

On March 28, 2008, NMFS received the final CIE Independent Peer Review reports. Two of the three reviewers indicated that the draft biological opinion made a scientifically credible argument and/or provided reasonable support that high flows to the estuary coupled with artificial breaching degrade steelhead rearing habitat (Largier 2008, Marston, 2008). A third reviewer provided additional support that the project adversely affects estuary habitat, however, he indicated the draft opinion's conclusion that the estuary would convert to a freshwater lagoon if not breached was not well supported (Bradford 2008). The comments of the reviewers have been considered and addressed as appropriate in this final biological opinion.

CDFG participated in the review of the June 11, 2007 draft biological opinion; CDFG also provided input in the development of the draft RPA for purposes of reaching a "consistency

[5] The CIE is part of the Rosentiel School of Marine and Atmospheric Science at the University of Miami. Its goal is to "provide both independent and expert reviews of the science necessary for the management of marine fisheries resources that are under the purview of the National Oceanic and Atmospheric Administration (NOAA) Fisheries."

determination" that the project will be implemented consistent with the California Endangered Species Act (CESA). Work on the RPA was largely completed by early April 2008.

During work on the RPA, the Corps, SCWA, 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 the Corps and SCWA on August 1, 2008, and indicated that the timeframe for analysis of the original proposed project would need to be changed from ten years to fifteen years (NMFS 2008b). 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, the Corps, and SCWA agreed to amend the period of the proposed project from ten to fifteen years (Russian River Project Executive Committee Meeting August 4, 2008). The RPA's approaches to addressing impacts to critical habitat were also discussed between SCWA and NMFS and modified subsequent to the August 1, 2008 working draft.

NMFS received additional comments on the working draft biological opinion from SCWA and the Corps on August 22, 2008. These comments were incorporated as appropriate. A complete administrative record of this consultation is on file at the NMFS Santa Rosa Office, 777 Sonoma Avenue, Santa Rosa, California 95404.

III. DESCRIPTION OF THE PROPOSED ACTION

A. Overview

This biological opinion analyzes the effects of the Russian River Water Supply and Flood Control Project (Project), operated or authorized by the Corps, on ESA-listed threatened and endangered salmonid species within the Russian River watershed. The Project includes operation of two dams and appurtenant facilities in the Russian River watershed. Together, the facilities are operated to control flooding within the watershed, to supply water to users within and outside the watershed, and to generate hydroelectric power. The altered flow regimes caused by the Project change the natural hydrology of the Russian River estuary, and artificial breaching of the sandbar is often required to prevent flooding adjacent to the estuary. In addition, the Project includes the operation of two fish hatchery facilities, and channel maintenance activities that keep the water delivery system functional and reduce the impacts of flooding in the mainstem and some tributaries of the Russian River. SCWA's scope of maintenance responsibilities covered under this Biological Opinion include maintenance of stream channels and small reservoirs in an area that SCWA terms Zone 1A, which consists of the Laguna de Santa Rosa and Mark West Creek watersheds, as well as maintenance activities on the Russian River main stem and the segment of Dry Creek downstream from WSD. The Corps maintenance activities include safety inspections at the two dams. In addition, MCRRFCD conducts channel maintenance activities related to the CVD in the Mendocino County portion of the Russian River. Channel maintenance by both counties is related to Federal sites and inspection of levees under Public Law 84-99 (non Federal) sites, but this consultation does not include implementation of the current Corps Operations and Maintenance manual for channel maintenance in the Russian River watershed. Instead, NMFS is consulting on channel maintenance practices as described below and referenced to the BA where appropriate.

In this Biological Opinion NMFS analyzes the implementation of the current operations of the Project for the next fifteen years. Fifteen years of current operations has been chosen due to future Russian River flow regime alternatives being considered by the Corps and SCWA. These agencies are working together to evaluate the impacts of flow regime changes on water supply, fisheries, recreation, and other uses and resources of the Russian River watershed. Potential water supply and stream flow regulation alternatives under consideration by these agencies cannot be fully analyzed based on the limited available information at this point in time. The Corps, SCWA, and NMFS agreed that it was prudent to evaluate project affects for the next fifteen year period because future changes in water supply operations contemplated by SCWA would likely take fifteen years to fully analyze and develop permits, water rights agreements/decisions that may affect additional water rights and related flow changes in the Russian River and Dry Creek.

The water supply and flood control elements of the Project involve the regulation of flood flows to control flooding in properties adjacent to the Russian River, and the storage of water in two reservoirs to be released for water supply in Sonoma, Mendocino, and Marin counties during the spring, summer, and fall. The water flows from the reservoirs down the main stem Russian River and Dry Creek to diversion points downstream of the dams. Part of the water stays in the river channels and flows into the Pacific Ocean at the river's mouth near Jenner. The diverted

water is delivered to end-users for municipal industrial, agricultural, and domestic uses. The keystone elements of the project are CVD, near the headwaters of the Russian, and WSD on Dry Creek, a main tributary of the Russian River. Russian River water is released from Lake Mendocino (the reservoir formed by CVD) for flood control, and, under the requirements of Decision 1610 (D1610), for water supply. Water released from Lake Sonoma (the reservoir formed by the WSD) is also released for flood control and water supply. D1610 set forth by SWRCB establishes minimum flow requirements for Dry Creek and the Russian River. Minimum stream flows under D1610 are specified for four different reaches in the Russian River watershed, assuring high enough summer flows to meet the diversion requirements as well as river-based recreational uses.

Lake Mendocino was created by the construction of CVD on the East Branch of the Russian River in 1958. The lake has a surface area of 1,922 acres (122,400 acre feet). The earthen dam, built and maintained by the Corps, is 160 feet high and 3,500 feet long. The project was developed to provide flood control, water for municipal, industrial, and agricultural uses, hydroelectric power, and recreational opportunities. The CVFF was constructed in 1992 at the base of CVD to mitigate for the loss of salmonid habitat upstream of the dam and the related loss of salmonid production.

Lake Sonoma was created by the construction of WSD on Dry Creek in 1983. The dam's purposes are flood control, and water delivery for industrial and municipal uses, and recreation. When full, the lake has a surface area of more than 3,600 acres (381,000 acre feet) and 50 miles of shoreline. At the time of construction, the DCFH was built at the base of WSD to mitigate for the elimination of fish habitat in the upper Dry Creek watershed and the related loss of salmonid production. The operation and programmatic purpose of the hatchery has changed to a more adaptive program since its inception. There have been operational changes towards salmonid conservation and recovery to further enhance mitigation goals and to fulfill the Corps obligation under Section 7 (a)(1) of the ESA. The current operation is described later in this document.

In addition to the two major dams in the Russian River watershed, there are several small storage reservoirs, levees, temporary dams, and other elements of the system that contribute to accomplishing the water supply and flood control goals of the Project and are discussed in subsequent sections of this consultation.

B. Project Elements

This section describes the specific Project elements that will be analyzed below in the Effects of the Action section.

1. Non-flood Water Supply Releases

D1610 of the State Water Resources Control Board (Board) requires SCWA, under its water right permits, to maintain minimum stream flows throughout specific reaches on the Russian River and Dry Creek. Minimum stream flows under D1610, summarized in Figure 1 are specified for four different reaches in the Russian River watershed: the East Branch Russian River from CVD to the confluence with the main stem, the main stem Russian River between the

East Branch Confluence and Dry Creek, the main stem Russian River between Dry Creek and the mouth, and Dry Creek downstream of WSD to the confluence with the Russian River.

Under D1610, required minimum flows in both the upper and lower Russian River vary depending upon defined water supply condition (Figure 1). Water supply condition is determined based on the cumulative inflow to Lake Pillsbury on the first of each month between January and June and is represented as *critically dry*, *dry*, or *normal*. The water supply condition can vary from month to month until June 1 when it becomes set until the following January. Because of the minimum flow requirements of D1610 in the Russian River and Dry Creek, SCWA must release additional flows above those necessary for municipal water supply.

Within the *normal* water supply condition, there is an alternate schedule commonly referred to as the *dry spring* criteria that is dependent upon the total combined storage in Lake Mendocino and Lake Pillsbury on May 31 of each year. The *dry spring* time water supply criteria affect releases from Lake Mendocino. These criteria allow reductions in minimum flows for the main stem Russian River when the combined storage falls below 90 percent and 80 percent of the combined capacities of Lake Pillsbury and Lake Mendocino. This provision reflects the “flashy” hydrology of the basin and the fact that the water supply is dependent on not only the quantity of runoff, but also the timing of runoff. Flood control operations do not allow conservation of winter runoff so fully filling the water supply pool requires spring runoff. Of the 90 water years simulated by the SCWA, approximately 11 percent of years consist of *dry spring* water supply conditions from June through December. *Dry spring* conditions do not apply to the January through May period.

The instream flow requirements for the Russian River downstream from its confluence with Dry Creek during *normal* water supply conditions were based primarily on a desire to maintain flows upon which the recreational industry on the Russian River had previously developed. The reduced minimum instream flow requirements for *dry* and *critically dry* water supply conditions were determined in consideration of warmwater fish species (such as smallmouth bass - *Micropterus dolomieu*) and wildlife needs, particularly for the lower portion of the Russian River. Salmonid needs were not considered. D1610 indicates that the required flows are beneficial for fish species, but that the flow releases to benefit fisheries can be reauthorized after D1610 was in place. D1610 states that "We (the Board) reserve jurisdiction to amend SCWA's permit if a fishery study is conducted which shows that a different flow schedule would be better, or if further evidence otherwise becomes available which may affect the minimum flows".

In 2002, NMFS issued a biological opinion on the Federal Regulatory Energy Commission’s (FERC) proposed license amendment for the operation of the Potter Valley Project. The biological opinion analyzed the effects on ESA-listed salmon and steelhead associated with the proposed operational changes and determined that the proposed amendment would cause jeopardy to listed salmon and steelhead in the Eel River (NMFS 2002). The biological opinion provided a reasonable and prudent alternative that reduces the historic annual average diversion from the Eel River to the Russian River at Potter Valley, requiring FERC to require the licensee to notify the State Water Resources Control Board so the board can assess the efficacy of D1610 (NMFS 2002). In January 2004, FERC issued an amended license for the Potter Valley Project

that incorporated the reasonable prudent alternative contained in the NMFS 2002 biological opinion.

The flow requirements for Dry Creek were based on the CDFG instream flow needs investigation performed in 1975 and 1976 (Barraco 1977). These requirements were developed to meet the fish spawning, passage, and rearing needs as determined by CDFG at that time. These flows were to sustain the native fish populations below WSD, to enhance steelhead and salmon spawning and nursery habitat in Dry Creek, and to facilitate operations of the DCFH at WSD.

Under current demand, during a normal summer, SCWA must release close to, and occasionally exceed, 300 cubic feet per second (cfs) from Lake Mendocino to allow for water supply demands above Healdsburg and still meet the 185 cfs minimum currently required by D1610 at Healdsburg. During the summer months, flow release targets are at least 10 to 20 cfs above the minimum flows at Healdsburg to ensure that instream flow requirements are met regardless of fluctuating demands. Because a change in release at Lake Mendocino may take 4 days to appear at Healdsburg, changes in demand must be anticipated several days in advance.

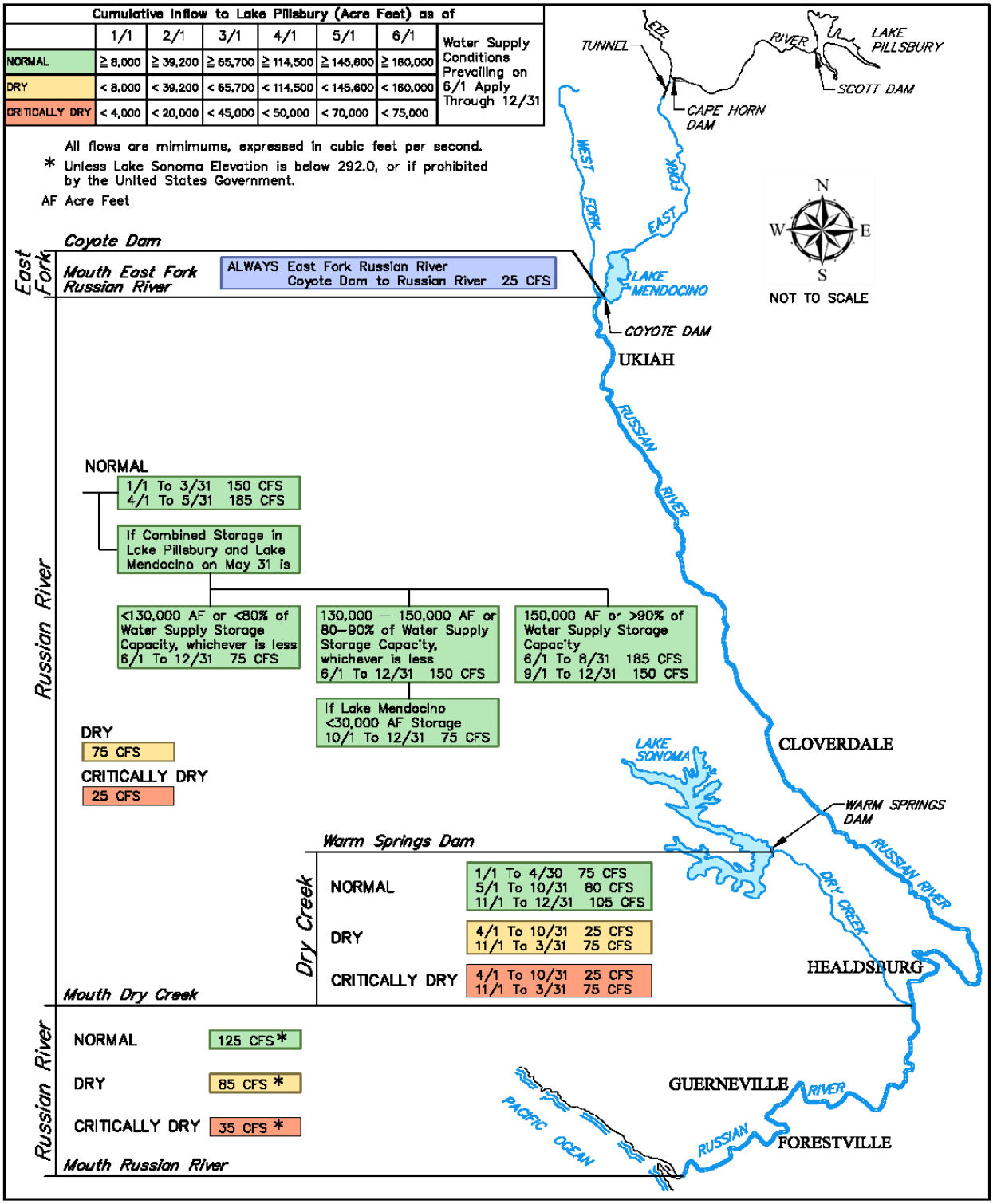

Figure 1. D1610 Russian River Basin Streamflow Requirements.

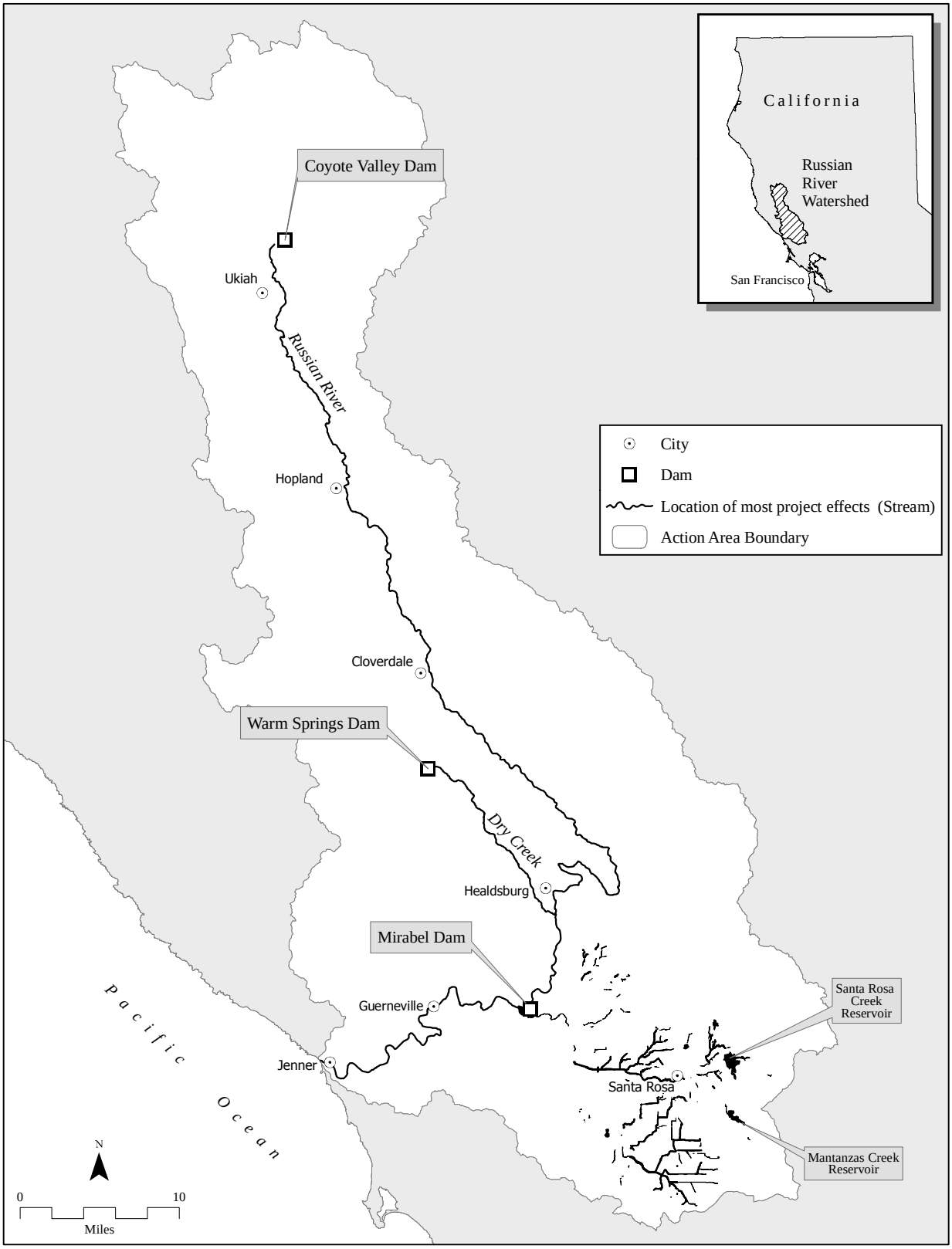

Figure 2. Main Action Area Streams. Action area includes all streams in Russian River watershed accessible to steelhead.

2. Estuary Management

NMFS completed a biological opinion on May 20, 2005, for issuance of a Corps 404 permit authorizing the SCWA to conduct breaching actions at the mouth of the Russian River from 2005 through 2009. This biological opinion will supersede the May 20, 2005, biological opinion.

The Russian River estuary is located near the town of Jenner, California. To breach it, SCWA will periodically excavate a pilot channel across the lowest point of the sand bar at the mouth of the Russian River when the estuary elevation rises to a point where low lying properties are threatened with flooding. The breaching actions will likely take place 4 to 11 times per year for the next fifteen years. SCWA will breach the sandbar with a bulldozer or excavator, allowing the estuary water to flow into the Pacific Ocean.

a. Breaching Criteria

The sandbar will be breached when water levels in the estuary are between 4.5 and 7.0 ft in elevation. SCWA's goal is to breach before water levels reach 7.0 ft at the Jenner gauge. Water levels are determined from an automated tide recorder[6] located at the Jenner Visitor's Center near the mouth of the Russian River (Corps and SCWA 2004). The maximum water elevation (7.0 ft) was selected to prevent flooding of property, minimize the potential for discharge of anoxic water from the Willow Creek Marsh into the estuary when the estuary is breached at high water levels, and to avoid high flushing velocities caused by high water elevations in the estuary prior to breaching.

b. Breaching Operations

The sandbar will be accessed from the paved parking lot at Goat Rock State Beach located at the end of Goat Rock Road off of Highway 1. Equipment (a bulldozer) will be off-loaded at the parking lot and driven onto the beach via an existing access point. A pilot channel will be created in the sandbar at a sufficient depth to allow river flows to begin transporting sand to the ocean. While the channel is dug, it will remain disconnected from the estuary by a portion of the sand bar to allow construction equipment to avoid flowing water. Excavated sand will be placed on the beach adjacent to the pilot channel. This excavation work will usually generate up to 1,000 cubic yards of sand, sidecast onto the sand bar below the high tide line (NMFS 2005). Once the channel is complete, the remaining portion of the sandbar will be removed by heavy equipment allowing the river water to flow to the ocean. The size of the resulting pilot channel varies depending on the height of the sand bar to be breached, the tide level, and the elevation of the estuary at the time of breaching. Typically, the breaching work proposed will result in a pilot channel approximately 100 ft long by 25 ft wide and 6 to 8 ft deep (Corps and SCWA 2004, NMFS 2005).

[6] Data from the tide recorder is displayed at the SCWA's Operations Center in Santa Rosa by remote telemetry.

c. Breaching Timing

The breaching schedule varies from year to year depending on the frequency of the closure of the Russian River mouth. As noted above, the periodic breaching is likely to occur from 4 to 11 times per year, based on data from past breaching events (Corps and SCWA 2004). Breaching can occur during any month of the year, though it most frequently occurs in the spring and fall. The following events or conditions are likely to result in breaching (Corps and SCWA 2004):

- If the estuary is closed to the ocean in mid-October, water releases from Lake Mendocino and Lake Sonoma for flood control will likely result in the need to breach.
- If the estuary is closed in the spring when late rain storms occur that are likely to raise water levels over 8.0 ft.
- D1610 water releases during the summer are expected to require estuary breaching to prevent flooding.
- Dry winters may result in the need for breaching if the mouth closes in the winter and rainstorms are imminent.

From 1996 through 2007, most breaching occurred in the late summer and fall, with spring breaching occurring in 8 out of 12 years (Table 26).

3. Channel Maintenance Actions

SCWA conducts channel maintenance activities in the Russian River and its tributaries for the purposes of flood and erosion control. SCWA's scope of responsibilities in the Sonoma County portion of the Russian River watershed include activities related to the Central Sonoma Watershed Project, portions of various creeks in Zone 1A, a large portion of the Russian River main stem in Sonoma County, and portions of Dry Creek below WSD. The Central Sonoma Watershed Project includes five flood protection reservoirs and constructed flood control channels that were built in the late 1960s to reduce flooding in the Santa Rosa area. The channels and reservoirs in this project are contained within SCWA's geographic Zone 1A (*i.e*, the Laguna de Santa Rosa and Mark West Creek watersheds). The areas along the main stem Russian River maintained by the SCWA include the sites originally constructed by the Corps as a response to anticipated changes to channel morphology following construction of WSD and CVD, and Public Law 84-99 sites. The MCRRFCD conducts channel maintenance and erosion control activities related to the Coyote Valley Dam Project (CVDP) in Mendocino County that encompass a large portion of mainstem Russian River. This includes channel maintenance related to Federal sites and inspection of levees under Public Law 84-99 (nonfederal) sites.

a. Channel Maintenance in the Mainstem Russian River and Dry Creek

SCWA and MCRRFCD propose to continue to conduct bank stabilization activities, gravel bar grading, and vegetation and debris removal activities in the mainstem Russian River in Sonoma and Mendocino counties, respectively. SCWA will also continue to maintain bank stabilization

sites in Dry Creek. These activities are conducted under Corps oversight[7]. SCWA's and MCRRFCD's bank stabilization activities on the Russian River mainstem will be limited to maintenance of past channel flood control improvement projects, including Public Law 84-99 for which the counties have assumed responsibility. In addition to maintaining channel flood control improvements installed for CVD and WSD, SCWA and MCRRFCD will continue to inspect and maintain channel flood control sites that were constructed between 1956 and 1963. SCWA also assists property owners with Public Law 84-99 sites. Where property owners agree to follow the methods and measures provided in the BA (Corps and SCWA 2004) to limit impacts to salmonids and their habitats, work done at these sites will be included as part of the proposed project. SCWA will then include these sites in the total length limits described below for channel maintenance activities in the mainstem Russian River.

Russian River. In general, SCWA and MCRRFCD will grade instream gravel bars that may be impeding flow, and inspect and maintain approximately 21 channel flood control improvement sites. Typical maintenance activities for channel improvement sites in the mainstem Russian River are similar to those on Dry Creek (see below), and include 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.

MCRRFCD will perform stream bank maintenance consisting of obstacle[8] removal, stream bank repair, and preventive maintenance over a 36-mile 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 MCRRFCD also is responsible for any channel maintenance actions in the East Branch Russian below CVD downstream to the confluence with the Russian River, a one mile reach (B.Spazek, MCRRFCD, personal communication 2007). SCWA will maintain a 22-mile reach from river mile 41 near the confluence of Maacama Creek upstream along the Russian River to river mile 63 just north of Cloverdale, including minor work at PL 84-99 sites. In addition, SCWA will, if necessary, repair failing banks at Mirabel and Riverfront Park.

No more than four maintenance sites are proposed for work in each county during the summer months. Each site will be limited in size and typically no more than 1,000 feet of maintenance work along the Russian River is expected for each county during any given year (Ron Benkert, SCWA, personal communication, 2-5-2008). As much as 2,000 feet of work may be done in any given year, with no more than 15,000 feet done in each county during the fifteen year project period (B. Spacek, MCRRFCD, personal communication, 2-8-2008). Channel Maintenance that may be performed at these sites includes:

[7] For example, the Corps inspects these sites in the Russian River and Dry Creek and indicates the amount and type of work that may be needed at each site. The most recent inspection was conducted in 1999 (Corps and SCWA 2001)

[8] Any in-channel obstacle which causes the stream to be directed into the riverbank. Typically the obstacles removed would be old jacks. However, MCRRFCD may remove LWD when it spans the channel (B. Spacek, MCRRFCD, personal communication, 5-7-08).

(1). Gravel Bar and Overflow Channel Maintenance in the Main stem Russian River

Certain conditions may warrant some degree of gravel bar grading. Grading activities may be conducted if one or more of these conditions exist:

-Occurrence of severe bank erosion.
-Recent substantial changes in channel morphology likely to lead to severe bank erosion.
-Evidence of weakened levees.
-Threats of flooding to infrastructure or private property.

SCWA and MCRRFCD will implement protocols described in the BA (Corps and SCWA 2004) to limit the potential for negative effects on salmonids or their habitat. For example:

-Gravel bar grading will only occur between July 1 and October 1.
-A buffer of at least 25 feet or 10 percent of the maximum bar width, whichever is less,will be maintained along the edge of the low flow channel, whether vegetation is present or not.
-The elevation of post graded bars will be at least 1.5 feet higher than the elevation of the edge of the low flow channel
-Sediment will be contoured to create a slope that runs up and away from the centerline of the main low-flow channel that is at least a 2 percent grade from the water surface elevation at low flow, or baseline elevation at the water surface, whichever is higher.
-Large woody debris removed or extracted will be placed either on the upstream buffer area or along the low flow channel buffer where it can be redistributed in the high flows of the next rainy season. If it poses a risk to property, it may be anchored or placed elsewhere in the river.

(2) Vegetation Maintenance in the Mainstem Russian River

Under the proposed Project, MCRRFCD will continue to perform vegetation maintenance to control bank erosion. Vegetation can be removed from river banks, levees, or gravel bars that contribute to bank erosion, consistent with protocols described in the BA (Corps and SCWA 2004) that limit the potential for negative effects on salmonids or their habitat. For example:

-Vegetation removal will occur outside of a 25 foot buffer zone next to the low-flow channel.
-Vegetation within the buffer will be cropped (mowed).
-In channels that are wider than 200 feet, a vegetated buffer of no less than 50 feet will be maintained.
- All vegetation removal work will occur during low flows, between July 1 and October 1.
-Native vegetation that is removed will be relocated to the extent possible.

Vegetation maintenance work may be conducted if one or more of these conditions exist:

-Encroachment by Giant Reed *(Arundo donax)* or other exotic pest plant species.

-Occurrence of severe bank erosion.
-Recent substantial changes in channel morphology that are likely to lead to severe bank erosion.
-Evidence of weakened levees.
-Threats of flooding to infrastructure or private property.

SCWA manages vegetation on the bed or banks of the Russian River from the Mendocino County line downstream to just above the confluence with Brooks Creek several miles upstream of the City of Headsburg, and several miles of the lower river just upstream from the estuary (as shown on Figure 3-5 in Corps and SCWA (2004). In these locations, SCWA manages the Russian River mainstem as a natural waterway. This management approach is described below in the Zone 1A description.

(3) Site-Specific Bank Stabilization in the Russian River.

Past channel maintenance areas, including those identified in the Corps Maintenance Manual for Dry Creek and Mainstem Channel Improvements, where frequent and/or extensive channel maintenance actions are required to prevent bank erosion will be identified. These sites may be candidates for bank stabilization projects by SCWA and MCRRFCD during the next fifteen years.

In addition, SCWA will conduct bank stabilization projects in the Mirabel or Riverfront Park sites in response to flood damage. SCWA anticipates flood damage may occur two to three times during the 15 year duration of the BO. When needed, this bank work will be included in the amount of work per year anticipated above (*i.e.*, the length of banks worked for these projects will be subtracted from 2,000 feet, leaving a smaller length of other bank work that may be done that year). Unless damage necessitates emergency repairs, remediation of bank failures will entail isolation and dewatering of the site using coffer dams. To avoid impacts to listed salmonids, fish would be removed from the site and construction would occur between July 1 and August 15.

Bank stabilization techniques employed by SCWA will favor a bioengineering approach with rock rip-rap placed only at the toe of banks upslope to the ordinary high water line. Any such project would heavily feature native vegetation re-planted on fill that is protected by erosion control fabric. Bank stabilization activities conducted by MCRRFCD will follow the methods described below for Dry Creek (*Methods 5 - 15*).

Dry Creek. SCWA Channel maintenance activities on Dry Creek are mostly limited to maintaining Corps channel flood control improvements at 15 locations that were installed to prevent bank erosion following construction of WSD. The total length of these sites is 5,800 feet and includes rock banks (3180 feet) and board fences (1600 feet). Other sites include concrete weirs, concrete sills and one rock sill and bank. There were no lengths provided for these other sites (Table 1).

Under the proposed project, SCWA will continue to maintain these 15 channel flood control improvement sites. Maintenance work associated with these sites can involve incidental

sediment removal, vegetation removal, removal of debris, and bank stabilization. Vegetation removal will only occur to improve bank stability if trees are leaning or otherwise directing high flows against the bank, causing erosion, and/or to visually inspect a bank stabilization structure. Bank stabilization work typically will involve replacing lost riprap and, if necessary, regrading the bank slope to its previous contours in order to provide a stable base for the riprap. SCWA anticipates that bank stabilization work will be limited to 10% per year of the total length of the 15 sites (Ron Benkert, SCWA, personal communication, 2-5-2008). Riparian vegetation on the channel banks and bars will be left in place, if not threatening bank stability, to maintain shade for aquatic habitat. The BMPs used in natural waterways described below (in *b. Zone 1A*) will apply to maintenance practices on Dry Creek as well.

Table 1. Channel improvement sites on Dry Creek. Source: Corps and SCWA 2004.

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	
13	Concrete Sill	
14	Concrete Sill	
15	Rock Bank	500

Some of these sites only require annual inspections while others may require repair. The methods of repair for these sites are described below.

The following is the Corps and SCWA (2004) description of the methods of bank repair in Dry Creek:

"Standardized maintenance methods and BMPs have been developed in conjunction with the Bay Area Storm Water Management Agencies Association (BASMAA) to minimize negative environmental effects (SCWA 1996b). (Method numbers not discussed in this section apply to sediment and debris removal, vegetation control, or activities in constructed channels)."

"*Method 5*: A dump truck, or excavator with an extended arm, is used to repair rock riprap or place rock in areas of slope undercutting, scour hole or bank slope erosion. Rock is dumped directly on the bank from a dump truck. If the face of the slope has eroded, the excavator digs a 2- to 3-foot-deep trench at the toe of the bank for the width of the eroded area. The excavating

equipment places 2 to 3 feet of rock into the toe, and rock riprap is placed up the bank from the toe. Smaller rock may be dumped to fill voids in the larger riprap.

Method 6 is used to repair large and long erosion areas. In addition to activities in Method 5, the excavating equipment may fill the area farthest from the channel slope with native soil or road-base shale and then compact the area. Rock riprap is placed up the band from the toe. Smaller rock may be dumped to fill the voids.

Method 7: Erosion areas around culverts are repaired by excavating the trench containing the culvert with excavating equipment, dumping sand, or native soil on the bank, and then using the excavating equipment to place the material into the trench. Portable compactors compact the fill. Six inches of road base is dumped into the excavated area and compacted using a roller/compactor.

Method 9: Dirt or rock access roads are repaired by dumping dirt or rock from a dump truck over the areas of road, spreading the material with a grader, and using a roller/compactor to compact the surface.

Method 10: Undercut pipe outfalls are repaired by replacing rock in scour holes below the pipe and reshaping the channel to direct flows away from the affected areas. If the erosion is deep, Method 6 is applied.

Method 11: Grouted rock is repaired by clearing the area of broken or damaged material with an excavator with an extended arm or a backhoe operated from the service road. Bank disturbance is kept to a minimum because equipment is not operated on the bank. Deeply eroded areas are repaired if necessary with Method 6. Rock riprap is placed on the bank of the stream channel bottom with Method 5 and grouted with ready-mix concrete from a shoot or a concrete pump.

Method 12: Minor underlining of a lined channel is repaired by accessing the area behind the lining from the top of the bank using hand tools or a backhoe to open a small access. A concrete/sand slurry ready mix would be distributed using a shoot or a concrete pumper.

Method 13: Major undermining repair would be contracted out. Historically, significant undermining has not occurred.

Method 15: When drop structures or check dams are repaired, water is diverted around the affected area. Isolation from flow would minimize sediment input and direct injury to fish. If the diversion is large, a dozer with a blade brings in or moves on-site material for construction of a berm or diversion dam.

b. Zone 1A

There are two types of channels managed by the SCWA in Zone 1A: constructed flood control channels and natural waterways. Most of the creeks in this zone are managed as both constructed flood control channels and natural waterways (Table 2). The upper portions of the creeks are usually managed as natural waterways and the lower portions, found in the more

urban areas, are typically constructed flood control channels. The activities implemented by SCWA for flood control purposes in the Zone 1A area (see Figure 3) include sediment removal, channel debris clearing, vegetation maintenance, and bank stabilization (on natural waterways only).

Constructed flood control channels (many of which are part of the Central Sonoma Watershed Project) are channels that have been altered (mainly by widening and straightening) based on flood control criteria. The purpose of the alterations is to increase hydraulic capacity. These channels have been straightened and in some places lined with concrete or riprap, converting the channel shape to a trapezoid. Also, these streams have been disconnected from their floodplains.

Natural waterways are waterways that have not recently been modified for flood control purposes by SCWA or USACE. Between 1958 and 1983 some of the natural waterways were straightened, shaped and stabilized. Regular maintenance on natural channels was historically performed with the objective of maximizing the hydraulic capacity without enlarging the channels. In the 1980's, SCWA staff would use heavy equipment and hand crews with chainsaws to clear vegetation from the bottom of natural channels. The use of heavy equipment ended in 1987, with clearing continuing to be performed by four-man crews using hand labor.

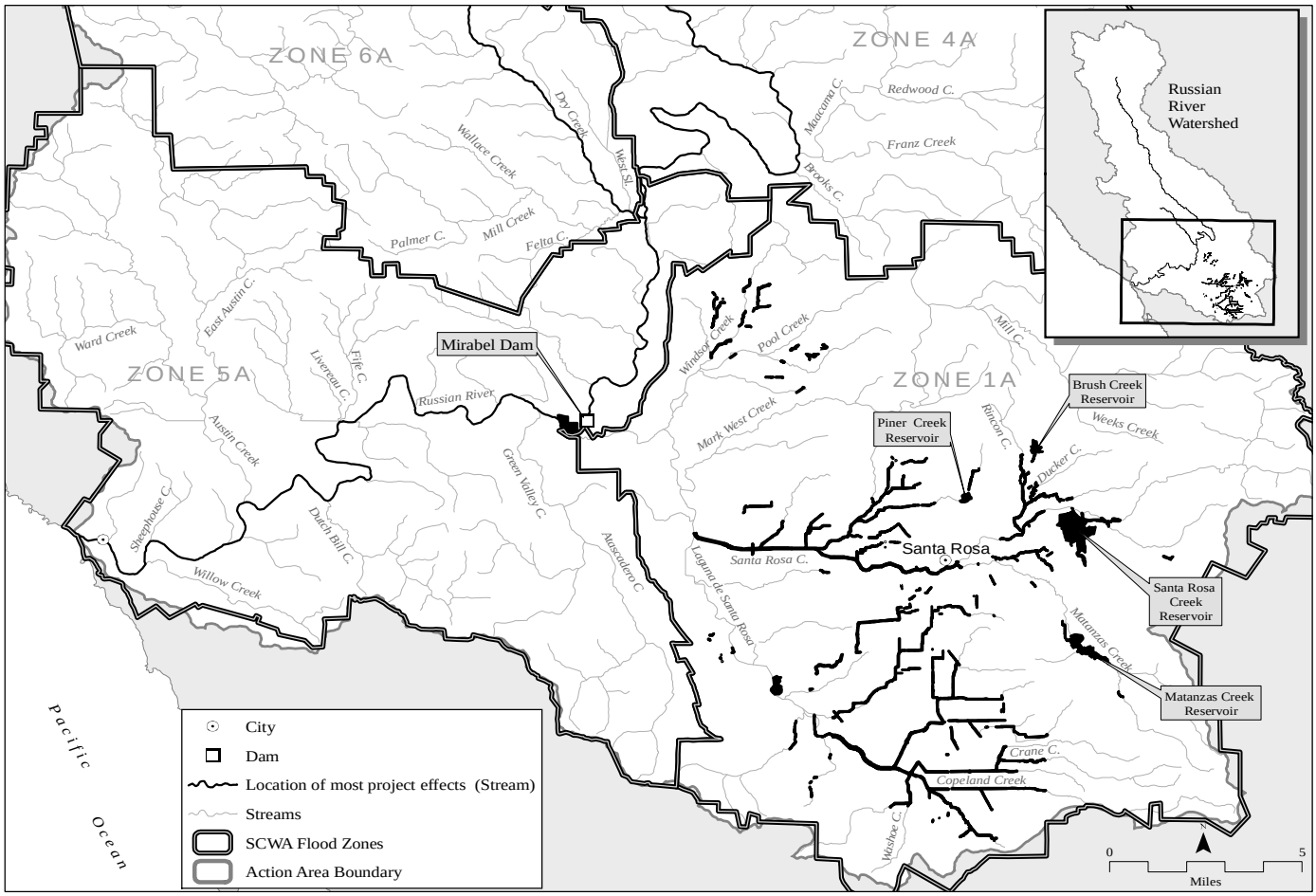

Figure 3. Detail of Action Area for Lower Russian River and Zone 1A

Table 2. Streams in Zone 1A where SCWA has proposed channel maintenance activities. F = flood control channels; N = natural waterways; S = known to contain steelhead (Corps and SCWA 2004, NMFS 2005d, CDFG 2006d). Streams are placed in three geographic groups: Rohnert Park – Cotati area streams, Santa Rosa Creek and its tributaries, and tributaries of Mark West Creek downstream of the confluence with the Laguna de Santa Rosa. Note: some streams have both channel types. Source: Modified from Corps and SCWA 2004.

Rohnert Park-Cotati Area		**Santa Rosa Creek**		**Mark West Creek**	
Blucher Creek	N, S	Austin Creek	F,S	Airport Creek	F
Coleman Creek	F, N, S	Brush Creek	F, S	Faught Creek	F
Colgan Creek	F, N	College Creek	F	Redwood Creek	F
Copeland Creek	F, N, S	Ducker Creek	F	Starr Creek	F
Cook Creek	F	Forestview Creek	F	Windsor Creek	F, N, S
Cotati Creek	F	Fountain Grove	N		
Crane Creek	F, N, S	Hood Mountain	N		
Five Creek	F	Indian Creek	F		
Gossage Creek	F, N	Lornadell Creek	F		
Hessel Creek	N	Matanzas Creek	N, S		
Hinebaugh Creek	F, S	Oakmont Creek	F, S		
Hunter Lane Channel	F	Paulin Creek	F, N, S		
Kawana Creek	F	Peterson Creek	F, S		
Laguna de Santa Rosa	F, N, S	Piner Creek	F, N, S		
Moorland Creek	F	Rinconada Creek	F, S		
Roseland Creek	F, N	Russel Creek	F		
Spivok Creek	F	Santa Rosa Creek	F, N, S		
Todd Creek	N	Sierra Park Creek	F, S		
Washoe Creek	N	Spring Creek	F, N, S		
Wilfred Creek	F, N	Steele Creek	F, N		
		Wendell Creek	F		

In addition to constructed flood control channels and natural waterways (discussed in the following section), SCWA maintains four flood control reservoirs built in the late 1960s to reduce flooding in the Santa Rosa area. Part of the Central Sonoma Watershed Project, these four flood control reservoirs are located on Santa Rosa, Brush, Paulin, and Matanzas creeks. The Santa Rosa Creek Reservoir (Spring Lake) is located off-stream. A diversion structure at the inlet allows relatively low flows to bypass the reservoir, routing the flow downstream into Santa Rosa Creek, while a portion of the higher flows are diverted into the reservoir. A diversion structure on Spring Creek also diverts water to Spring Lake. Spring Lake drains back to Santa Rosa Creek through a stand pipe when water levels become too high. Other than the Santa Rosa Creek Reservoir, the other flood control reservoirs are situated on-stream and are equipped with facilities (low-flow bypass and principal spillway) that allow minimum streamflows to be released. All of these reservoirs operate passively and are not equipped with flood control gates.

Facilities are not provided for anadromous fish passage above the in-stream flood control reservoirs or the diversion on Spring Creek. However, a fish ladder and vortex weir are located on Santa Rosa Creek to assist anadromous fish passage around Spring Lake.

Sediment removal and vegetation removal activities are necessary to maintain channel capacity and control stream bank erosion. Many of the constructed flood control channels maintained by the SCWA were designed to provide 100-year-flood capacity. The original design capacity assumed that stream banks will be predominantly grass, with little or no tree growth, and the streambed will be maintained clear of vegetation and sediment.

Under the proposed project, SCWA will continue to conduct channel maintenance activities within constructed flood control channels and natural waterways in Zone 1A, and maintain the four flood control reservoirs described above. Because emergency channel maintenance actions may occur when adult and smolt salmonids are in streams, and because the frequency and magnitude of these actions cannot be reliably estimated, NMFS is not addressing emergency actions in this biological opinion that occur during times when adult and smolt salmonids may be present in streams (November 1 through June 14). These emergency actions will need to be addressed by the Corps and SCWA through the separate emergency consultation procedures available under section 7 of the ESA.

Constructed Flood Control Channels in Zone 1A. Excessive sediments tend to be deposited during winter and spring flows at locations where the channel gradient significantly decreases and as the channel traverses from the steep gradient headwaters to the low-gradient valley plain. In these areas, and others, vegetation can also reduce channel capacity. Sediment and vegetation removal are conducted on an as-needed basis. For example, some of the constructed flood control channels require annual sediment removal, some require sediment removal less frequently, and some have never required sediment removal. Culverts (box culverts and metal culverts), culvert outfalls, and bridges also may require sediment removal.

These channels generally have service roads to facilitate maintenance access. SCWA will schedule stream sediment removal when field inspections indicate that the invert elevation of outfall structures is generally less than 12 inches above the streambed elevation. Sediment removal will be performed during summer or fall months until October 31. Only segments of constructed flood control channels that have become hydraulically impaired will have sediment removed. Sediment removal will consist of 1) excavation of bars that have accumulated bed material and have become enlarged by deposition over time, and 2) removal of sediment at road crossings and culvert outfalls.

A hydraulic assessment of selected Zone 1A constructed flood control channels was performed in 2000 to identify flood capacity under various vegetation management scenarios (Entrix 2002). The hydraulic assessment showed that for many of the channels, moderately dense shrubby vegetative growth with young developing willows (approximately 5 years old) on portions of the stream bank, and tule growth on the streambed, will cause impairment of hydraulic capacity, so that the 100-year flood might not be contained. To maintain original-design-flood capacity in these channels, SCWA will keep vegetation from growing into a dense brushy stage. Should the amount of vegetation in these channels be greater than that described above, these channels will likely not be able to accommodate the flows necessary to prevent floods.

Since the early 1990s, access roads have been cleared with aquatic contact herbicides (which are effective only at the time of application [*i.e.*, early spring]) and mowing. SCWA uses a truck

mounted tank and spray bar to apply Aquamaster® (EPA Reg. No. 524-343). The spray bar is eight feet wide and set one foot above the road surface to minimize drift. For road applications, the surfactant Agri-Dex®, Cal. Reg No. 5905-50094-AA, is added to the herbicide. The concentration is 1.5 gallons of Aquamaster® per 100 gallons of water. The concentration of Agri-Dex® is 0.5 gallons per100 gallons of water. Spraying occurs during the early morning hours and is discontinued if wind speed exceeds 5 mph (SCWA 2008a).

(1) Sediment Maintenance and Channel Debris Clearing Practices. Sediment removal will be conducted with excavators with extended arms, and in some areas, with bulldozers and front-end loaders as well. Excavating equipment with a reach appropriate for the channel being cleared will be used. The equipment will be driven along the access road, and sediment removal will be done perpendicular to the channel length. Bulldozers will be used in high width/depth ratio channels where excavators cannot reach the channel bottom from the service road. A bulldozer will stockpile sediment to a closer area and then stockpiles will be removed with an excavator.

Before large woody debris is to be removed, it will be evaluated by SCWA staff. If it is determined to be stable (*i.e.*, not likely to be dislodged, washed downstream, and threaten the integrity of a structure), it will be left in place. For example, a piece of large woody debris was left in place on Brush Creek recently because it was downstream of the Highway 12 bridge and was not in a position to float downstream and cause a debris jam at any bridges. Loose pieces of large woody debris may be anchored in place if found in an area where they are not likely to pose a threat. If large woody debris appears in a constructed channel in downtown Santa Rosa, particularly if it is 20 feet or longer, it is likely to become lodged at a bridge and create a blockage. Large woody debris presenting this kind of threat to infrastructure will be removed. If large woody debris is determined to pose a hazard, it will be removed in consultation with CDFG and NMFS. Large woody debris will be removed with a winch from the top of the bank, cut up with chain saws, and transported away. Brush will be chipped and put on landscaped areas.

(2) Sediment removal at road crossings and culvert outfalls. Removing sediment from culverts (metal and concrete box), under bridges, and transition areas near these road crossings will typically be accomplished with small sized construction equipment (a Bobcat or powershovel, for example) working within the structure or channel. The in-channel equipment will move material to an excavator positioned at the top of the bank. Sediment will then be transferred to a dump truck for offsite disposal. Transition areas will typically extend 25-50 feet upstream and downstream from the structure, depending on the volume of material being removed.

Removing sediment at culvert outfalls will involve the the use of a backhoe at the top of a channel bank to extract accumulated sediment within 5 to 10 feet adjacent to the outfall. Similar to sediment removal at road crossings, sediment removed from outfalls will be disposed off-site. Sediment removal at road crossings and culvert outfalls will be done during the summers when streambeds are dry.

(3) Vegetation Maintenance Zones. To manage vegetation in constructed flood control channels, SCWA has apportioned the vegetation maintenance activities into five “zones”: top-of-bank, upper channel bank, middle channel bank, lower channel bank, and the channel bottom. Maintenance activities in top-of-bank and upper channel are consistent among all constructed

flood control channels. Maintenance activities in the lower three zones (middle, lower channel bank and channel bottom) will vary depending on channel capacity and flood risk.

- **Top-of-Bank**. The top-of-bank zone maintenance includes:

  -landscape maintenance
  -fence/gate maintenance
  -V-ditch and drop inlet maintenance
  -service road maintenance

- ***Upper, Middle, and Lower Banks.*** The upper and middle channel bank zones typically consist of the upper two-thirds of the channel bank (which is generally everything above 5 feet higher than the channel bed). The lower channel bank zone comprises the area in the lower third of the channel bank (typically lower than approximately 5 feet above the channel bed), including the toe of the channel.

(3) Vegetation Maintenance Levels

The level of vegetation maintenance applied will depend on the hydraulic capacity required in the constructed flood control channel. One of three vegetation management practices will be applied, maintenance of the original design capacity, intermediate vegetation maintenance, or mature riparian vegetation maintenance.

- ***Original Design Capacity Maintenance*.** In site-specific areas where the hydraulic assessment (Entrix 2002) indicates that simulated flows are near or just over-bank, vegetation will be maintained at the original-design-capacity scenario. Vegetation maintenance practices may include limiting vegetation on stream banks to predominantly grass with little or no woody stem growth; maintaining the channel bottom clear of vegetation; and frequent maintenance.

- ***Intermediate Vegetation Maintenance*.** Channel maintenance practices in the lower channel zone will consist of the removal of understory vegetation. Understory vegetation removal (*e.g*., blackberries) will be accomplished by hand-clearing and use of aquatic herbicides**.** Small, mechanized equipment may be used to transport the cut vegetation to the top-of-bank so that it may be efficiently removed from the channel. Removal of plants will be selective, based on the species present, with an emphasis on protecting native riparian species wherever possible. Native trees (typically willows) that are growing along the lower one-third of the bank, including the toe of the bank where it intersects the channel bed, will be allowed to colonize as young trees. Herbicides are applied directly to cut stumps below top of bank. A 100% concentration of Aquamaster® mixed with Turf Mark®, a blue dye spray indicator, is applied using a paint brush.

- ***Mature Riparian Vegetation Maintenance***. In some channels, complete canopy cover could be achieved by allowing the development of mature, single-trunk trees with most of the canopy above the floodway elevation. Native trees will be

maintained (*i.e.*, thinning or pruning) or planted. Vegetation at the channel toe and in the lower third of the bank will be maintained parallel with the flow and spaced 15 to 25 feet, depending on the species. Lower limbs will be pruned to maintain channel capacity. To achieve a mature canopy cover, adequate flood capacity must exist in the channel both during the period when young trees are growing within the floodway and at later mature stages when these trees have canopies that rise above the floodway elevation.

- ***Channel Bottom.*** The channel bottom of constructed flood control channels will be cleared of vegetation through the use of spray aquatic contact herbicides and hand clearing. Future selected vegetation clearing from the channel banks may be necessary to allow access to the channel bottoms for silt removal operations. Small, mechanized equipment may be used to transport the cut vegetation to the top-of-bank so that it may be efficiently removed from the channel. SCWA will utilize backpack sprayers containing Aquamaster® without a surfactant to control invasive non-native species. Backpack spraying would also help control established nuisance species such as cattails (*Typha sp*.) and blackberry (*Rubus sp*.) that compromise channel hydraulic capacity.

(4) Application of Vegetation Maintenance Levels in Constructed Flood Control Channels

Portions of some channels with potential salmonid habitat will require design-capacity maintenance practices. An adaptive management approach will be implemented to assess which channels may in the future have maintenance protocols that allow more vegetation to grow.

For bridges and culverts that do not have the capacity to pass the 100-year discharge under intermediate maintenance, it will be necessary to implement design capacity vegetation maintenance practices near the bridge structures. These may include removing all vegetation except grasses within approximately a distance equal to the channel top-width both upstream and downstream from the bridge.

Natural Waterways in Zone 1A. SCWA has hydraulic maintenance easements that are permissive, and SCWA will continue to access various natural creeks to remove debris (LWD and trash) or vegetation to restore hydraulic capacity. SCWA will not perform routine sediment removal activities in natural waterways. In addition, SCWA will not perform any flood control maintenance activities in the Mark West Creek mainstem or tributaries of Mark West Creek upstream of the confluence with its largest tributary, the Laguna de Santa Rosa. This latter area is the only portion of Zone 1A with high potential to support coho salmon.

SCWA has developed BMPs and other guidelines for planning and implementing sediment removal and bank stabilization work performed in natural waterways to protect listed species and to minimize the potential for significant habitat alterations. SCWA will continue to use the BMPs and guidelines summarized below:

-Bank stabilization projects are not to exceed 1,000 feet in length for any single project.
-Projects cannot occur within 1,000 feet of a previously armored site.
-Construction will occur during the summer to avoid salmonid spawning and incubation periods.

-A qualified fisheries biologist will consult on the project design prior to implementation to consider all feasible alternatives. Habitat and biological resources in the area will be evaluated.
-Projects will develop in consultation with CDFG.
-Bio-engineering bank stabilization methods will be given priority where they will provide effective erosion control.
-Where bio-engineering bank stabilization methods are not deemed to be practical, priority will be given to incorporating vegetative plantings into the hard-armoring techniques that are implemented.
-Fish habitat restoration elements (such as native material revetments) will be incorporated into bank stabilization practices where they are feasible with the intention of replacing lost habitat.
-Large woody debris will be removed from the channel only if it threatens to de-stabilize a section of stream bank.

(1). Vegetation Management Practices in Natural Waterways

For the natural channels within Zone 1A where vegetation removal may occur, SCWA does not have routine or regularly implemented maintenance obligations. Maintenance on natural waterways (Table 2) will consist of clearing vegetation from the bottom of natural waterways to restore hydraulic capacity. Hand labor is the typical clearing method. Heavy equipment will only be used to lift out or clear debris jams not accessible to hand crews.

Flood Control Reservoirs. Flood control reservoirs are designed to impound water during the rainy season to reduce the potential for flooding in downstream urbanizing areas. Brush Creek Reservoir (130-AF capacity), Piner Creek Reservoir (230-AF capacity), and Spring Creek diversion (negligible capacity) are relatively small reservoirs. Both Brush Creek Reservoir and Spring Creek reservoir typically dry up by the summer (B. Oller, SCWA, personal communication 2001). Matanzas and Spring Lake reservoirs have larger capacities (1,500 AF and 3,500 AF, respectively). Spring Lake is located offstream of Santa Rosa Creek and does not dry up or release water downstream during the summer. Matanzas Creek Reservoir is a flow through reservoir that does not impound water in the summer.

Maintenance activities in the flood control reservoirs include desiltation and removal of noxious pondweeds. Desiltation, debris removal, and vegetation removal will also be performed at the inlets and outfalls to the reservoirs. Sediments will be excavated to restore the flood control capacity.

4. <u>Reservoir Flood Control Operations - Coyote Valley Dam and Warm Springs Dam</u>

a. Coyote Valley Dam Flood Operations

The Corps' main objective for flood control releases from Lake Mendocino is to prevent flood flows on the East Fork Russian River from contributing to overbank flood stages on the Russian River below CVD, to the extent possible. The specific criteria for flood control operations are described in the Water Control Manual for Coyote Valley Dam (Corps 1986a). The general criteria for releases from the flood control pool call for successively increasing releases in three stages as reservoir levels rise toward the emergency spillway. The USGS Hopland stream gage, 14 miles downstream of CVD, is the most downstream monitoring point for decisions affecting

flood control releases from Lake Mendocino. The Corps limits releases from Lake Mendocino to prevent local flooding at Hopland that generally occurs when flows exceed 8,000 cfs. Because bank sloughing is likely to occur when flows decrease too rapidly, the Corps has imposed a maximum ramp down rate of 1,000 cfs per hour for Lake Mendocino.

The Corps has developed modified guidelines for the rates at which releases from WSD and CVD may be changed during flood control operations. The existing Water Control Manuals allow releases to be changed at up to 1,000 cfs per hour when outflows from the reservoir exceed 1,000 cfs. To protect spawning gravel and juvenile salmonids within the Russian River and Dry Creek, the Corps developed interim guidelines (Corps 1998) for release changes with technical assistance from NMFS and CDFG (Table 3).

Table 3. Maximum ramping rates for CVD and WSD.

Reservoir Outflow	Down Ramping	Up Ramping
0-250 cfs	25 cfs/hour	1000 cfs/hour
250-1,000 cfs	250 cfs/hour	1000 cfs/hour
>1,000 cfs	1,000 cfs/hour	2000 cfs/hour

The Corps follows the existing guidelines 90 percent of the time (P. Pugner, Corps, personal communication, 2000). More specific directions are included in Exhibit A of the CVD water control manual, entitled "Standing Instructions to Damtenders" (Coyote Valley Dam Standing Instructions). Operation for flood control is described by the Flood Control Diagram summarized in Exhibit A:

> *Flood Control Schedules 1, 2 and 3 releases are used to empty the flood control space following a storm. Under these schedules, releases will be limited to: (1) the discharge that does not cause the flow at the Russian River near Hopland to exceed 8,000 cfs, and (2) the discharge that results in flow at Hopland being less than that reached during the previous storm or storm series. The previous storm or storm series is defined as the events which caused the highest pool at Lake Mendocino. In addition, releases will be limited to (1) at least 2,000 cfs and up to a maximum of 4,000 cfs if the reservoir pool did not reach elevation 746.0 feet, (2) up to a maximum of 4,000 cfs if the highest reservoir pool reached was between elevation 746.0 feet and 755.0 feet, and (3) up to a maximum of 6,400 cfs if the pool exceeded elevation 755.0 feet. Releases will not be increased or decreased at a rate greater than 1,000 cfs per hour. Schedules 1, 2, and 3 are used if no significant rainfall is predicted.*
>
> *When the QPF[9] is 1 inch or more for the next 24 hours or 1/2 inch or more for any 6-hour period in the next 24 hours, outflow from the lake should be limited to 2,000 cfs or less to the extent possible, so that the release can be reduced to 25 cfs within 1-1/2 hours if necessary (includes 2 hours to travel to control tower and make first gate change). Also, when the flow in the Russian River at Ukiah*

[9]. The QPF (quantitative prediction forecast) is generated by the California Nevada River Forecast Center.

exceeds 2,500 cfs and is rising, releases from Lake Mendocino will be reduced to 25 cfs, insofar as possible.

Outlet gates may be used when the pool is above the spillway crest (elevation 764.8) for Flood Control Schedule 3 releases, however the sum of the spill and the releases must not exceed 6,400 cfs, subject to the above limitations.

The Emergency Release Schedule is used when the pool elevation is above 771.0 feet. Continue to follow the Emergency Release Schedule if the pool elevation is between 771.0 feet to 773.0 feet. At elevation 773 feet and above, the flood control gates are fully open. The flood control gates will remain fully open until the lake has receded below elevation 773 feet. If the pool is receding and is between elevation 773.0 feet and 771.0 feet, follow the Emergency Release Schedule. Flood Control Schedule 3 releases are made when the lake has receded below elevation 771.0 feet.

Discharge capacity from the reservoir, with all gates open, is 5,950 cfs when the water surface elevation (WSE) is at the bottom of the flood control pool (*i.e*., when the water WSE reaches the stage when the reservoir is converted from water supply operation to flood control operation), and 6,700 cfs at full pool. Releases above this level would require use of the spillway. The design discharge capacity of the spillway is 35,800 cfs.

b. Warm Springs Dam Flood Control Operations

The Corps' primary objective for flood control operation at Warm Springs Dam is to reduce peak flood discharges in Dry Creek and the Russian River below Healdsburg to the extent possible. Because of the long travel time for water flow between CVD and the Russian River/Dry Creek confluence, flood control operations at WSD are generally independent of the CVD operation; however, operations of the two facilities are coordinated to avoid downstream flooding. The criteria for flood control operation of Lake Sonoma are similar to those for Lake Mendocino, and are described in the Warm Springs Dam Water Control Manual (Corps 1984). As with Lake Mendocino, flood control includes three successive flood release schedules. For Lake Sonoma, the Hacienda gage near Guerneville, located 16 miles downstream of WSD, is the most downstream monitoring point for decisions affecting flood control releases from Lake Sonoma.

To the extent possible, the Corps manages releases from Lake Sonoma to limit flows on the Russian River at Guerneville to 35,000 cfs, which is the approximate channel capacity in Guerneville. The Corps also limits releases to prevent flooding downstream along Dry Creek, which generally occurs when flows just below the dam exceed 6,000 cfs. As with releases from Lake Mendocino, the Corps limits changes in releases to 1,000 cfs per hour to prevent downstream bank sloughing.

More specific directions are included in Exhibit A to the Warm Springs Dam Water Control Manual (Corps 1998b), entitled "Standing Instructions to Damtenders". Operation for flood control is described in the Flood Control Diagram that is summarized below:

Flood Control Schedule 1, 2, and 3 releases are used to empty the flood control space following a storm. Under these schedules, releases will be limited to: (1)

the discharge that does not cause the flow in the Russian River near Guerneville to exceed 35,000 cfs, and (2) the discharge that results in flow at Guerneville being less than that reached during the previous storm or storm series. The previous storm or storm series is defined as the event(s), which caused the highest pool at Lake Sonoma. In addition, releases will be limited to a maximum of: (1) 2,000 cfs if the reservoir pool did not reach elevation 456.7 feet, (2) 4,000 cfs if the highest reservoir pool reached was between elevation 456.7 feet and 468.9 feet, and (3) 6,000 cfs if the pool exceeded elevation 468.9 feet. Releases will not be increased or decreased at a rate greater than 1,000 cfs per hour. When the pool elevation is at or below 502.0 feet and inflow is at or above 5,000 cfs no gate releases will be made. Schedules 1, 2, and 3 are used only if no significant rainfall is forecasted.

Significant rain is forecasted when the QPF is 1 inch or more for the next 24 hours or ½ inch or more for any 6-hour period in the next 24 hours. Under this condition, outflow from the lake should be limited to 2,000 cfs or less to the extent possible, so that the release can be reduced to the minimum required flow within 1½ hours if necessary. The 1½ hours includes time to travel to the control tower and make the first gate change.
Flood Control Schedule 3 releases will be maintained until elevation 502.0 feet is reached by regulation of the outlet so that the combined flow from spills (pool above elevation 495.0 feet) and releases through the outlet works does not exceed 6,000 cfs.

The Emergency Release Schedule is used when the pool elevation is between 502.0 feet to 505.0 feet. At elevation 505 feet and above, the flood control gates will be fully opened. The flood control gates will remain fully open until the lake has receded below elevation 505 feet, at which time the Emergency Release Schedule is again implemented. When the lake has receded below elevation 502.0 feet, Flood Control Schedule 3 is implemented.

Because of the watershed's configuration above Lake Sonoma, direct measurement of reservoir inflow by stream gaging is impractical. Consequently, inflow is calculated as the algebraic sum of releases, changes in storage, and estimated evaporation.

Water is released from WSD for flood control purposes through the outlet works or through the spillway, which are located on the left abutment of the dam. The control structure accommodates multiple intakes that can be used to meet water quality requirements. Maximum discharge capacity of the outlet works is 8,100 cfs when the reservoir pool is at 513.1 feet above MSL. The spillway was designed for a discharge of 29,600 cfs, with the maximum reservoir pool elevation being 18 feet above the spillway crest.

c. CVD and WSD ramping rates

Working with NMFS and CDFG in 1998, the Corps evaluated ramping rates for flood control releases at CVD and WSD. The result of this coordination was "Interim Ramping Rates" that have been implemented since 1999 at both dams (see Table 3).

In the summer months when main stem Russian River and Dry Creek flows are predominately controlled by D1610, ramping rates are generally 25 cfs per hour (A. Mai, SCWA, personal communication, January 2006). The adjustments to reservoir releases are provided by SCWA to the Corps for WSD, and to the Northern California Power Agency (NCPA) for CVD to meet D1610 minimum flow requirements at Healdsburg, Guerneville, and Dry Creek.

d. Pre-Flood and Periodic Dam Inspections

*Coyote Valley Dam***.** Pre-flood inspections at CVD will be conducted annually, and occur on one day during the month of September for the fifteen year period under consultation. Periodic inspections occur once every five years. The inspections will involve ramping down flow releases from the dam to zero, a two-hour inspection period will occur with zero flow release, and then ramping up to normal operating flow (Table 4). Ramping down to the zero phase for inspections will not exceed a period of more than four hours. During this phase, the project will ramp down in increments of 25 to 50 cfs. During the zero flow release phase of the action, the Corps will inspect the 5 by 9-foot service and emergency gates, the 720-ft long steel-lined concrete conduit, and the facility outlet works. Other activities the Corps conducts on the day of the inspection will include inspection of the dam embankments,

Table 4. Typical schedule of release flows and various actions related to inspections of CVD. Source: Corps and SCWA 2004.

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

instrumentation, spillway, tower access bridge, bulkhead and slide gates, hydraulic power system, emergency generator, reservoir rim, and access roads. During the two-hour time period of zero flow release from CVD, the Corps will provide a minimum of five cfs of flow from the stilling basin[10] below the dam. The flow of five cfs from the stilling basin is provided from discharge that is released from the basin as it drains during the zero flow release period.

The Corps proposes to monitor stream reaches below CVD during the pre-flood inspection activities. Two person stream survey crews will survey specific stream reaches below the dam

[10] A basin constructed to dissipate the energy of fast-flowing water from a spillway or bottom outlet and to protect the streambed from erosion.

(within the action area) and make observations related to changes in stream characteristics and fish distribution as a result of the proposed action.

Warm Springs Dam. A pre-flood or periodic inspection of dam structure and operating systems also occurs during August or September at WSD. The Corps conducts inspections of WSD at specific times of the year and manner to avoid adverse effects to juvenile and adult salmonids. Unlike CVD, which must halt flow during inspections; WSD is able to provide a minimum of 25 cfs during the pre-flood and periodic flood inspections. The Corps provides a minimum bypass flow of 25 cfs, but actual flows measured by the U.S. Geological Survey-Water resources Division (Ukiah Field Office) are typically 40 cfs. Inspections are conducted 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 the inspection. Surveys conducted by NMFS and the Corps during the inspections have not found stranding of juvenile salmonids. Conducting inspections in late August or September also allows the Corps to avoid Chinook salmon spawning in Dry Creek that usually begins in October.

By avoiding adverse effects to juvenile steelhead and adult Chinook salmon with inspection timing and bypass flows, the Corps has obtained NMFS' yearly concurrence (since 1998) that these activities are not likely to adversely affect listed salmonids or their critical habitats. NMFS expects that future inspections at WSD will also not likely adversely affect listed salmonid species or critical habitat, unless the Corps changes the manner in which the WSD inspections are carried out. Therefore, this aspect of the project is only considered briefly in the remainder of this biological opinion.

5. Hatchery Operations

The DCFH, also known as Warm Springs Hatchery, is located at the base of WSD. Its satellite facility, CVFF, is located at the base of CVD. Construction of DCFH was authorized by the Flood Control Act of 1962. Additionally, Section 95 of Public Law 93-251, of the Water Resources Development Act of 1974, required a program to compensate for fish losses attributed to the operation of CVD, and allowed for expansion of DCFH. The DCFH and CVFF facilities went into service in 1980 and 1992, respectively. Because the hatchery operations are required as mitigation for the purpose of the proposed action, NMFS is analyzing the effects of all hatchery operations in this biological opinion.

Both fish facilities are owned by the Corps, however, the facilities and hatchery programs are operated by CDFG under contract with funding from the Corps. Although funding for some operational components is uncertain, the Corps proposes to continue operations of the DCFH and CVFF fish production facilities, including the coho salmon and steelhead programs, but not Chinook salmon (Corps and SCWA 2004). Both of the fish facilities and hatchery programs were intended to serve as mitigation for the loss of historical salmonid spawning and rearing habitat blocked by the construction of WSD and CVD. Annual escapement goals of 1,100 adult coho salmon, 6,000 adult steelhead and 1,750 adult Chinook salmon in the Dry Creek drainage, and 4,000 adult steelhead in the upper Russian River drainage, were established to provide mitigation for losses resulting from construction and operation of WSD and CVD (Corps 1986b).

a. *Russian River Coho Salmon Captive Broodstock Program (RRCSCBP)*

The DCFH coho salmon mitigation and enhancement program began in 1980, and coho production at the facility was stopped entirely in 1996, after failing to meet mitigation goals. In 2001, the RRCSCBP was initiated 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 Russian River basin. The Corps proposes continuation of the RRCSCBP as an integrated recovery program (Corps and SCWA 2004).

The RRCSCBP was initiated at DCFH with juvenile wild coho salmon collected from Russian River tributaries. The juveniles were reared to reproductive maturity. The program then artificially spawned the adult captive broodstock while adhering to a genetic spawning matrix to maximize genetic diversity of the coho salmon produced, and to minimize adverse affects to the genetic composition of the Russian River coho salmon. Juvenile coho salmon produced from the captive broodstock were then released into several Russian River tributaries as fry, so that they could return to the streams as adults and spawn naturally. Each year since 2001, the program has reared and stocked coho salmon with lineage to wild juvenile coho salmon collected in Russian River tributaries. The RRCSCBP is currently authorized under an ESA section 10(a)(1)(A) enhancement permit issued to CDFG (Permit 1067, modification 3). Since the effects of the RRCSCBP have already been evaluated in the September 26, 2001, NMFS biological opinion on the issuance of the section 10(a)(1)(A) enhancement permit for the program, the specific effects of the program will not be evaluated as part of the proposed action in this biological opinion, but are included in the Environmental Baseline of this biological opinion.

The proposed continuation of the captive broodstock program will have similar objectives to the existing RRCSCBP (Corps and SCWA 2004). The program will continue to collect naturally-produced juvenile coho salmon, rear the fish to maturity, and use them as broodstock to produce fingerlings (Corps and SCWA 2004). Spawning will be conducted following a genetic spawning matrix to maximize genetic diversity of the coho salmon produced. The juvenile coho salmon would then be released into appropriate streams in the Russian River basin (Corps and SCWA 2004). The objectives of the captive broodstock program are to: 1) prevent extirpation of Russian River coho salmon; 2) preserve genetic, ecological, and behavioral attributes of Russian River coho salmon while minimizing potential effects to other stocks and species; and 3) build a naturally-sustaining coho salmon population (Corps and SCWA 2004).

The Corps proposes to continue the monitoring program to evaluate the effectiveness and performance of hatchery operations. As part of monitoring, the results of population status monitoring programs conducted by others will be tracked closely (Corps and SCWA 2004). Hatchery operations will incorporate adaptive management practices, which could lead to changes in hatchery production guidelines (such as number of juveniles released, size of juveniles released, or use of wild fish for broodstock) based on monitoring program findings (Corps and SCWA 2004). The monitoring program will be used to monitor and evaluate release strategies, over-summer survival, over-winter survival, and adult coho salmon returns. Data collected from the monitoring and evaluation program will be used to continue to assist in the adaptive management of the program.

b. Steelhead Mitigation Program

The Corps (and CDFG) have recently taken initial steps to begin transitioning the steelhead mitigation program from an isolated hatchery program[11] to an integrated hatchery program[12], and they have incorporated operational changes that have been implemented due to revisions in CDFG policy and guidelines (Corps and SCWA 2004). Since the steelhead program is not authorized under the ESA, the specific effects of the steelhead hatchery programs are considered in this opinion.

Broodstock Collection and Spawning. Russian River adult steelhead broodstock are collected from the DCFH and CVFF fish ladders and traps. DCFH and CVFF steelhead are collected randomly across natural run-timing, with weekly capture goals formulated from weekly adult return records for a 9 to 11 year period. Steelhead from both facilities are managed separately, that is steelhead collected from DCFH are only spawned with other steelhead collected from DCFH, and steelhead from CVFF are only spawned with steelhead collected from CVFF. Steelhead program guidelines routinely aim to collect and spawn a minimum of 180 females at DCFH and a minimum of 120 females at CVFF, and generally 2.5 to 3 times those numbers for males. Adult returning hatchery steelhead are spawned randomly at both fish facilities. More individuals are spawned than are necessary to achieve egg-take goals, both in an attempt to increase genetic diversity and as a means to protect against catastrophic loss during incubation and early rearing of hatchery steelhead. Adult wild steelhead that return to DCFH are relocated into Dry Creek and adult wild steelhead that return to CVFF are relocated to the West Branch Russian River above Mumford Dam. Adult hatchery steelhead that return to DCFH that are not needed for broodstock are released into the main stem Russian River, upstream of the confluence with Dry Creek. Adult hatchery steelhead that return to CVFF that are not needed for broodstock are relocated to the Ukiah and Cloverdale reach of the main stem Russian River, and to tributaries to the upper Russian River including: Ackerman, Feliz, Orr, Gibson, Doolan, Mill (tributary to Forsythe), Hensley, McClure, McNab, Morrison, Parsons, Howell, Dooley, McDowell, Twining, and Walker creeks. Beginning in 2004, adult excess hatchery steelhead from both facilities are not relocated above natural barriers in the Russian River in order to avoid compromising the genetic integrity of isolated resident trout stocks (based on results from Deiner (2004) discussed in the Environmental Baseline section).

Rearing. Based on a fecundity of 5,000 eggs per female and a 50 percent survival rate from egg to yearling, 600,000 steelhead eggs are collected for DCFH releases, and 320,000 eggs for CVFF releases. Juvenile steelhead from each facility are reared separately at DCFH and are not graded during the rearing process. Grading of hatchery fish is typically carried out to sort the sizes of fish during the rearing process to minimize aggressive behavior and potential cannibalism of smaller fish by larger faster growing fish.

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[11] A hatchery program in which artificially propagated fish are produced primarily for harvest and the primary goal is to maintain hatchery broodstock that are distinct from their wild counterparts by using predominately or exclusively hatchery origin adults returning to the hatchery (HSRG 2004, Spence *et al.* 2008). .

[12] A hatchery program in which the primary goal is to minimize genetic divergence between hatchery broodstock and naturally spawning wild populations by systematically incorporating wild fish into the hatchery broodstock (HSRG 2004, Spence *et al.* 2008).

Approximately 40,000 pounds of yearling smolt stage fish are trucked to CVFF in three separate lots in late January/early February and March, for 4 to 6 weeks of rearing for acclimation and imprinting before volitional release into the East Branch Russian River.

Fish Marking. All steelhead produced at DCFH and CVFF are marked with a clipped adipose fin prior to release to identify the steelhead as a hatchery fish.

Releases. DCFH and CVFF steelhead are released as smolts at approximately 4 to 5 fish to the pound (FishPro Inc. and Entrix Inc. 2000), a size that encourages rapid emigration to the Russian River estuary (FishPro Inc. 2004). Releases occur between mid-January and late April, after steelhead juveniles transition from freshwater parr to euryhaline smolts, having the ability to live in salinities varying from fresh water to full-strength seawater (Zaugg 1981). DCFH steelhead are transported and released 3 miles downstream from the hatchery in Dry Creek at the Yoakim Bridge to facilitate out-migration. CVFF steelhead are volitionally released from the facility after the 4 to 6 week acclimation and imprinting time period. A maximum number of 300,000 steelhead are released from DCFH, and a maximum of 200,000 are released from CVFF.

c. Program Management

Water Supply. 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). The Corps has upgraded the water supply at CVFF to help ensure emergency backup should the primary water supply fail. The emergency water supply line for DCFH is currently non-functional and plans for its repair remain uncertain.

Monitoring and Evaluation.
Monitoring data are collected annually at both fish facilities on returning adult steelhead, including numbers, gender, and mark type (ad-clip hatchery or wild).

6. Hydroelectric Facilities at Coyote Valley and Warm Springs Dams

a. Hydroelectric Power Plant at Coyote Valley Dam

The Lake Mendocino Hydroelectric Power Plant (LMHPP), owned and operated by the City of Ukiah (City), was completed in May 1986 at a total cost of approximately $22 million. The power plant was added as an external facility to the downstream base of CVD, which was not originally designed to supply a hydroelectric plant (City of Ukiah 1981). The power plant has a total generation capacity of 3.5 MW through two generators rated at 1 MW and 2.5 MW, respectively. The City operates the project under a 50-year license issued April 1, 1982, by FERC (Project No. 2481-001). The City is a member of the Northern California Power Authority (NCPA).

NCPA owns and operates various power generation plants throughout California and provides power to their members. The LMHPP supplements other power sources within the City's system and has no contractual minimum power 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. During 2005, the City worked with NMFS to develop an operations plan to minimize impacts to salmonids in the Russian River. NMFS technical assistance focused on potential effects to salmonids during the transitions between flood and power operations. The City, NCPA, and NMFS settled on an operations plan (dated August 25, 2005) that included operation criteria to reduce potential effects to listed salmonids. The City has made modifications to the tainter gate at Lake Mendocino and operation of the power plant resumed bypassing flow in January 2007

b. Hydroelectric Power Plant at Warm Springs Dam

SCWA owns and operates the Warm Springs Dam Hydroelectric Facility (WSDHF). This hydroelectric facility was completed in December 1988 at a total cost of $5 million. SCWA operates the facility under a 50-year license issued by FERC on December 18, 1984 (Project No. 3351-002). The 3,000-KW Francis turbine generator has a power rating of 2.6 MW (Corps 1984). The facility is located within the control structure of the outlet works for 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. The upper tunnel was non-operational, but was repaired in 2002. Water from the tunnels travels down the vertical well between (approximately) 115 and 194 feet feet to the turbine. Water passing through the turbine flows into the flood control tunnel to a stilling basin located at the base of the dam. A 20-inch emergency water supply line installed inside the conduit provides water to the hatchery in the event of a gate failure. This bypass line was engineered to divert water through the hatchery and to Dry Creek at a maximum flow capacity of approximately 35 cfs. As noted above, the emergency water supply line is currently not functional.

From the stilling basin, water flows through a channelized portion of Dry Creek, or is diverted for use in DCFH adjacent to WSD. The stilling basin is a concrete-lined basin at the mouth of the outlet tunnel. A two-step weir, approximately 18 feet high, is used to reduce the water velocity from the outlet tunnel and to keep fish downstream of the dam from entering the outlet tunnel.

The hydroelectric facility operates during normal releases of water through the low-flow tunnels and the wet well. A minimum flow of approximately 70 cfs is needed to operate the turbine. The maximum flow capacity for the turbine is approximately 185 cfs. During flood control operations (when releases from WSD exceed 3,000 cfs), flow through the wet well and turbine are shut off to prevent hydraulically unstable conditions from developing in the outlet piping. When water releases of more than 500 cfs are required, service gates in the left abutment of the intake conduit are opened, and flows bypass the wet well and turbine. The minimum opening allowed for the service gates is 0.2 feet, which relates to a release of 100-120 cfs. Also, flows of 185 cfs through the turbine can continue, with the remaining flow bypassed through the service gates. However, the total flow through the wet well and the service gate must be less than 3,000 cfs.

Flows through the hydroelectric facility are determined by water supply needs and minimum instream flow requirements. The turbines can operate at flows of 70 to 185 cfs. The water

supply needs and minimum instream flow requirements set by D1610 (SWRCB 1986) generally provide flows sufficient for hydroelectric power generation, and the plant operates on flow releases for other purposes. No flow releases are made solely for the benefits of hydroelectric generation.

C. Interrelated and Interdependent Actions

Interrelated actions are those 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 (50 CFR 402.02). NMFS considers SCWA's water diversion and transmission system to be interdependent with water releases at CVD and WSD.

1. Water Diversion Operations

SCWA delivers water to its customers through its water transmission system, which has a peak monthly average delivery of 84 million gallons per day (mgd), and a capacity of up to 92 mgd. The diversion and treatment facilities are located along the Russian River in Forestville at Mirabel (an area near the former Mirabel resort) and Wohler (a site near Wohler Road). The transmission system, which includes pipelines, storage tanks, pumps, and conventional wells, conveys water from the diversion facilities on the Russian River to service areas in Sonoma County and Marin Counties.

a. Diversion Facilities

SCWA's diversion facilities along the Russian River include an inflatable dam, the Mirabel diversion facility and infiltration ponds, and the Wohler diversion facility and infiltration ponds. The ability of the Russian River aquifer to produce water is generally limited by the rate of recharge to the aquifer through the streambed near the Mirabel and Wohler diversion facilities. To augment this rate of recharge, SCWA has constructed seven infiltration ponds and a water-filled inflatable dam located on the Russian River just upstream of the Mirabel area (Figure 2). When the dam is inflated, it raises the water level and submerges the intakes to three diversion pumps which can deliver up to 100 cfs. 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 increase in water level also increases recharge to the Wohler collectors and allows SCWA to flood two infiltration ponds (1.7 acres combined) in the Wohler area.

The Inflatable Dam. The inflatable dam at Mirabel is fabricated of a rubberized material and is attached to a concrete foundation in the riverbed. When inflated, the dam is 11 feet (ft) high and spans the width of the entire river. The inflatable dam usually will be raised in late spring when water demands increase and the Russian River stream flow drops below 2,000 cfs. The dam is inflated slowly with water. Under current protocols, inflation of the dam generally takes approximately 12 hours (hrs) to complete, whereas deflation takes 24 hrs. Given that the dam is 11 ft high, stage-change in the river upstream of the dam is about 0.92 feet per hour (ft/hr) during inflation and 0.46 ft/hr during deflation. Stream flow spills over the dam until the dam is two-thirds inflated, at which point most of the flow passes through fish ladders and associated bypass

structures. The dam will be operating for about 7 months each year, on average. The dam will be lowered in the fall or early winter when stream flow approaches 2,000 cfs. When the dam is deflated, it does not impede migration or create a backwater. The inflatable dam is equipped with Denil-style fish ladders near the riverbank on each side of the dam, both of which are in operation when the dam is raised. Each fish ladder has an approximate flow capacity of 40 cfs. Two 24 to 36-inch bypass pipelines provide water at each of the fish ladder entrances to attract adult fish to the ladder. Each bypass pipeline allows about 22 cfs of flow. In an effort to reduce juvenile salmonid residency and migration time through the Wohler Pool, which is formed by the Mirabel Dam, the SCWA has proposed a minor change in the operation of the inflatable dam. The SCWA will create a depression in the crest of the inflatable dam during outmigration periods (spring through June 15) to provide concentrated flow at a point along the crest of the dam to reduce delay of smolts at the forebay.

Infiltration Ponds. The Mirabel diversion facility is located on the west side of the river adjacent to the inflatable dam. At the inflatable dam, water is drawn through two submerged fish screens that are 11 ft in diameter, about 5 ft high, and rotate on vertical axes. The current fish screen's openings are 5/32 of an inch, which do not meet NMFS fish screen criteria of 3/32 of an inch. A small water jet drives paddle blades attached to the top of the screen to rotate the screens; vertical fixed brushes clean the screens of debris and biological fouling as the screens rotate. After flowing through a sedimentation pond adjacent to the diversion caisson, diverted water enters a small open channel, which distributes water to up to four infiltration ponds through manually-operated slide gates.

SCWA will replace the rotary drum fish screens at Mirabel to meet NMFS criteria for screen openings within the next ten years. Replacement will entail diversion of the Russian River around the site using coffer dams. SCWA anticipates it will require 5 to 7 years to design and construct this project element in coordination with NMFS.

The Wohler diversion facilities consist of two ponds with a combined surface area of 1.7 acres. Currently, each pond is connected independently to the Russian River by a canal. These canals function as both inlets and outlets to the ponds. The Wohler ponds operate only when the inflatable dam is raised. Flows diverted into the Wohler ponds are not measured. A screen constructed out of metal T-posts and ¼-inch hardware cloth, which does not meet NMFS screen criteria, is installed in front of the inlet to the Wohler infiltration ponds. These ponds have not been used by SCWA for several years.

The infiltration ponds at Wohler and Mirabel are sometimes overtopped during floods, trapping fish in the ponds after the river level recedes. This happens at the Wohler ponds during most winters due to a lack of levees around the ponds, and less frequently at the Mirabel ponds, which are protected by levees. To relocate trapped fish, biologists from the SCWA use beach seine nets after pond levels drop to a depth where wading is possible.

To provide the primary water supply for the transmission system, the SCWA 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 aquifer beneath, and adjacent to, the streambed.

Collector Wells. Each collector well consists of a 13- to 18-foot-diameter concrete caisson that extends 80 to 100 ft deep into the alluvial aquifer. Perforated horizontal intake pipes extend radially from the bottom of each caisson to a maximum of 350 ft 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 10.0 to 21 mgd, and at Mirabel each pump is rated to deliver up to 10.0 mgd.

Vertical Wells. Seven vertical wells, collectively referred to as the Russian River Well Field, are located in the Mirabel area shown on Figure 2. These wells withdraw 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 Pipleline, 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 SCWA system also includes three groundwater wells located along the Russian River-Cotati Intertie pipeline at Occidental Road, Sebastopol Road (Highway 12), and Todd Road.

b. Treatment Facilities

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

Water Chemistry. SCWA operates pH adjustment/corrosion control facilities to limit lead and copper content in drinking water. These facilities are located at the SCWA Wohler maintenance yard and the River Road chlorination building. There water is treated with caustic soda to raise the pH of pumped Russian River water. Although the water produced by the existing collectors 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 (one at Wohler and one at the River Road facilities). 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 a leak occurs within the pH control buildings.

SCWA currently disinfects the water produced at the well facilities with approximately 0.6 parts per million (ppm) of 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 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. At the Occidental, Sebastopol Road and Todd Road wells, calcium hypochlorite tablets are used on-site to generate an aqueous chlorine solution.

c. Transmission System

Currently, the SCWA water transmission system has 86 miles of 16 to 54-inch diameter pipe in place to distribute water from the diversion facilities to water users in Sonoma and Marin counties. The SCWA 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 ESA-listed salmonid species or critical habitat, though unplanned releases from the transmission system may affect ESA-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 0.6 ppm. To reduce the likelihood of corrosion of the pipelines, the SCWA has buried magnesium alloy anodes at regular intervals (typically every 20 to 40 feet) to generate a small electrical current on the exterior of the pipelines.

d. 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 ESA-listed species or critical habitat (see *Effects of the Project*). 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 stream banks 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 dam is lowered, the fish screens at Wohler are removed so they are not damaged during high-water events. Raising the 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 using a portable suction dredge, and discharge is directed to a temporary settling pond to prevent turbid water from reaching the river channel. The water is allowed to re-enter the river after the sediment has settled. Spoils are then stored out of the flood plain or hauled away.

Groundwater Wells Maintenance. Operation of SCWA's Occidental Road, Sebastopol Road, and Todd Road wells can require discharging well water to surface drainages for sampling or flushing purposes. However, these discharges usually involve unchlorinated water and are conducted infrequently. The discharged water at the Occidental well discharges into a reclamation pond; the Todd Road well discharge is spread over nearby fields not adjacent to salmonid bearing streams, and the Sebastopol Road well discharge is sent to a drainage ditch which does not enter a salmonid bearing stream (A. Mai, SCWA, personal communication, 2007). 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 recoating of the interior tank surfaces, which requires that the tanks be emptied. To the extent

possible, the water in the tanks is drained into the transmission system. However, to maintain pressures within the transmission system, a portion must be released from the tank to surface water drainage. In these cases, prior to discharging, the SCWA maintenance staff estimates the remaining volume of water in the storage tanks and adds a corresponding amount of dechlorinating chemical (metabisulfide) to eliminate any chlorine residual in the discharge. Controlled discharges occur approximately once every 4 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 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. The protocols for gravel bar grading operations conducted to increase infiltration capacity may differ from those conducted for channel maintenance. Therefore, these activities are discussed separately.

Infiltration capacity at the Wohler and Mirabel diversion facilities will be augmented by periodically recontouring three gravel bars in the Russian River upstream of the inflatable dam (Wohler, McMurray, and Bridge gravel bars) and one bar (Mirabel Bar) downstream of the inflatable dam. Work in other gravel bars may be required in the future if the pattern of gravel bar formation in the river changes so that new bars are formed. These will likely be located between Caisson 6 and Caisson 3. The McMurray and Mirabel bars are approximately 1,000 ft long and 200 ft wide. The other two gravel bars are approximately 500 ft long and 100 ft wide.

The following best management practices (BMPs) for gravel bar grading operations were evaluated by SCWA during a 5-year monitoring study (Chase *et al*. 2000) and will be implemented as part of the proposed project. Biological oversight will be provided by fisheries biologists. SCWA biologists will inspect the gravel bars before beginning gravel skimming work to: a) evaluate the need for silt fences, and b) identify environmentally sensitive areas. Permanent vegetation on the riverbanks may in some cases be thinned to allow equipment access to the bar, but will not be completely removed. Sediment fences will be employed to prevent the input of sediment into the river. Cofferdams will be constructed both upstream and downstream of the work areas, if necessary, to isolate the work areas from flowing water. Operation of heavy equipment in the active stream channel will be limited to moving equipment to and from the mid-channel gravel bars and breaching cofferdams when needed, and will be very short in duration. All equipment will be removed from the gravel bars at the end of each day. No fueling or equipment service will be performed on the gravel bars or within the active floodplain. Gravel skimming operations will be limited to material above the waterline. After gravel bar grading operations are completed, gravel bars will be contoured to at least a 2 percent grade to reduce the potential for stranding fish. Continuously recording turbidity meters will be installed upstream and downstream of gravel bar grading operations to document turbidity levels

associated with this action. Breaching of the lower berm for the Mirabel Bar will be conducted late in the evening or early in the morning to reduce visual effects to recreational visitors at Steelhead Beach.

2. Wastewater Treatment

Project operations for purposes of water supply result in the diversion of approximately 65,000 acre-feet of water from the Russian River (Corps and SCWA 2004). A substantial portion of this water supply is consumed, eliminated as waste, treated as wastewater, and ultimately discharged back into the Russian River watershed or San Pablo Bay as treated effluent. Corps and SCWA (2004) state that eleven wastewater treatment plants (WWTPs) serve SCWA's primary and secondary water contractors, including contractors who divert water under SCWA's water rights.

Wastewater discharges are controlled and scheduled under the established policies of the Water Quality Control Plan for the North Coast (NCRWQCB 1993). Water treated to the secondary level or better (as described in the *Environmental Baseline*) 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. While discharge schedules vary between treatment facilities, the WWTP generally limit their discharges to months with relatively high seasonal flows. 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 April 30. Under the permits filed with NCRWQCB, the identified treatment plants 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.

D. 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: 1) the East Branch Russian River below CVD and the main stem Russian River from the confluence of the East Branch Russian River to the mouth of the Russian River at Jenner (including the Russian River Estuary), 2) Dry Creek downstream of WSD, and 3) areas of the Mark West Creek watershed that do not contain coho salmon, including Santa Rosa Creek and its tributaries, and the Laguna de Santa Rosa, in Area Zone 1A (Figures 2, 3, and Table 4). However, the action area is extended to include the entire Russian River and its tributaries downstream of WSD and CVD because of our need to also consider the impacts of straying hatchery fish in the watershed. Interrelated and interdependent activities, such as wastewater discharge, and water transmission, can also occur in or near streams in Sonoma County and Marin County outside of the three main areas of effects identified above.

IV. STATUS OF THE SPECIES AND CRITICAL HABITAT

The purpose of this section is to characterize the condition of the three salmonid species under consultation relative to their likelihood of viability (extinction risk) and to describe the conservation role and function of their respective critical habitats. The three principle components to this section are: 1) a summary of relevant life-history characteristics for each species; 2) a viability assessment for all three species; and 3) an analysis of critical habitat. This information will be used as the foundation for determining whether the proposed project is not expected to appreciably reduce the likelihood of the survival and recovery of a species by reducing the reproduction, numbers, or distribution of that species, or result in the destruction or adverse modification of critical habitat.

In the previous draft of this opinion, NMFS applied Viable Salmonid Population (VSP) criteria (McElhany *et al*. 2000) to population diversity strata to diagnose ESU/DPS status. Subsequent to that analysis, the NMFS Southwest Fisheries Science Center published the results of the Technical Recovery Team's (TRT) status assessment for the ESUs and DPS under consideration in this biological opinion (Spence *et al*. 2008). We have updated our status section below to reflect this more recent scientific information. Because we maintained contact with the TRT during our previous diagnosis of status, our previous conclusions regarding ESU and DPS status are consistent with the TRT's work. We have changed organization, and refocused our analysis on the viability of populations and ESUs or DPSs to better comport with the TRT's status assessment. We have also clarified terms in our critical habitat analysis and provided ESU or DPS summaries of critical habitat. In our previous draft we included predation as an attribute of the migratory corridor PCE of critical habitat; however, to be consistent with our designation of critical habitat (70 FR 52488), we eliminated this habitat attribute in our analysis of critical habitat.

In addition, we considered Southern Resident Killer Whales. This species is known to occur in the Pacific Ocean off the coast of California as far south as Monterey Bay. Because these marine mammals prey mainly on Chinook salmon (78 percent of identified prey)[13] (NMFS 2008a), and this proposed project is likely to adversely affect some Chinook salmon in the Russian River, we considered whether or not this proposed project would adversely affect Southern Resident Killer Whales. However, as described below in the *Effects of the Proposed Action* and *Integration and Synthesis* sections, the proposed project has little, if any, effect on overall Chinook salmon numbers and distribution in the Russian River, and overall has beneficial impacts to Chinook salmon critical habitat. Therefore, with minimal impacts on CC Chinook salmon numbers, distribution, or reproduction, NMFS expects the proposed project is unlikely to adversely affect Southern Resident Killer Whales. For that reason, Killer Whales are not discussed further in this biological opinion.

A. Life History

A brief overview of the life history of each salmonid is provided below in order to illustrate the importance of survivorship at each life stage in the overall abundance and productivity of each

[13] Coho salmon and steelhead are thought to comprise 5 percent and 2 percent of their diet, respectively (NMFS 2008a).

species. More detailed information is available in Good *et al.* (2005) and the NMFS final rule listing the CCC steelhead DPS (71 FR 834).

1. Chinook Salmon

Chinook salmon are the largest anadromous member of *Oncorhynchus*, with adults weighing more than 120 pounds having been reported from North American waters (Scott and Crossman 1973, Page and Burr 1991). Chinook salmon exhibit two main life history strategies: "ocean type" and "river type" (Healy 1991). 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. River type fish are typically spring or summer run fish that have a protracted adult freshwater residency, sometimes spawning several months after entering freshwater. Progeny of river type fish frequently spend one or more years in freshwater before emigrating. The CC Chinook salmon are fall-run, ocean-type fish. A spring-run (river-type) component existed historically, but is now considered extinct (Bjorkstedt *et al*. 2005).

Chinook salmon in the CC Chinook salmon ESU generally remain in the ocean for two to five years (Healy 1991), 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 main stem or lower tributaries of rivers, and spawn within a few weeks of freshwater entry (Healy 1991). However, some return from the ocean to spawn one or more years before full sized adults return; these are referred to as jacks (males) and jills (females). Run timing is, in part, a response to stream flow characteristics, with most spawning occurring in November and December. They 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 river or estuary productivity is sufficient for juvenile survival and growth. Adult female Chinook salmon prepare redds in stream areas with suitable gravel composition, water depth, and velocity. 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 (Allen and Hassler 1986). 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 (Allen and Hassler 1986). Gravels are unsuitable when they have been cemented with clay or fines or when sediments settle out onto redds, reducing intergravel percolation (62 FR 24588). Minimum intergravel 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 Chinook salmon's need for a strong, constant level of subsurface flow may indicate that suitable spawning habitat is more limited in most rivers than superficial observation would suggest. After depositing eggs in redds, adult Chinook salmon guard the redd from 4 to 25 days before dying (Healy 1991).

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 (Leidy 1984). 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.

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 (Everest and Chapman 1972). 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 (Chapman and Bjornn 1969, Everest and Chapman 1972). Optimal temperatures for both Chinook salmon fry and fingerlings range from 12 to 14°C, with maximum growth rates at 12.8°C (Boles 1988). 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.

The low flows, high temperatures, and sand bars that develop in smaller coastal rivers during the summer months favor an ocean type life history of Chinook salmon (Hooton *et al*. 1995). With this life history, subyearlings typically undergo a physiological transformation called smoltification. This process, which begins as they migrate downstream, prepares them for living in the marine environment. The smolt out-migration typically occurs from April through July (Myers *et al*. 1998). In California, ocean type Chinook salmon tend to use estuaries and coastal areas for rearing more extensively than stream type Chinook salmon (Thorpe 1994). Brackish water in estuaries moderates the physiological stress that occurs during the parr-smolt transition.

Many of the fry of ocean-type Chinook salmon migrate downstream immediately after emerging from spawning beds and take up residence in river estuaries to rear to smolt size (Healy 1991). 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 parts per thousand (ppt) salinity) before moving into a transition zone (5.5 to 25 ppt salinity) between May and July. After that they move into a more marine zone (>25 ppt salinity) (Thorpe 1994). 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. However, MacFarlane and Norton (2002) demonstrated little estuarine dependency for juvenile Chinook salmon in the San Francisco estuary. These conflicting results suggest variability in the use of estuaries, some of which may be attributable to the highly modified condition of San Francisco Bay.

2. <u>Coho Salmon</u>

The life history of coho salmon in California has been well documented by Shapovalov and Taft (1954) and Hassler (1987). In contrast to the life history patterns of other anadromous

salmonids, coho salmon in California generally exhibit a relatively simple 3-year life cycle (Shapovalov and Taft 1954, Hassler 1987). Adult coho salmon typically begin the freshwater migration from the ocean to their natal streams after heavy late-fall or winter rains breach the sand bars at the mouths of coastal streams (Sandercock 1991). Delays in river entry of over a month are not unusual (Salo and Bayliff 1958; Eames *et al*. 1981). Adult migration continues into March, generally peaking in December and January, with spawning occurring shortly after the fish return to the spawning grounds (Shapovalov and Taft 1954).

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 head of a riffle, just below a pool, 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 grounds have nearby overhead and submerged cover for holding adults, water depths of 10 to 54 cm, water 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 intergravel 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 (Briggs 1953). Fecundity of coho salmon is directly proportional to female size; at the southern end of the species range (*i.e*., California and Oregon) average fecundity is about 2000 eggs (Sandercock 1991). 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. The newly-hatched fry remain in the gravel from two to seven weeks before emergence (Shapovalov and Taft 1954).

Upon emergence from the gravel, coho salmon fry seek out shallow water, usually along stream margins. As they grow, they often occupy habitat at the heads of pools, which generally provide an optimum mix of high food availability and good cover with low swimming cost (Nielsen 1992). Chapman and Bjornn (1969) determined that larger parr tend to occupy the head of pools,

with smaller parr found further down the pools. As the fish continue to grow, they move into deeper water and expand their territories until, by July and August, they are in the deep pools. Juvenile coho salmon prefer well shaded pools at least 1 meter deep with dense overhead cover; abundant submerged cover composed of undercut banks, logs, roots, and other woody debris; DO levels of 4 to 9 mg/l; and water velocities of 9 to 24 cm/s in pools and 31 to 46 cm/s in riffles. Water temperatures for good survival and growth of juvenile coho salmon range from 10 to 15°C (Bell 1973; McMahon 1983). Growth is slowed considerably at 18°C and ceases at 20°C (Stein *et al*. 1972; Bell 1973). The likelihood of juvenile coho salmon occupying habitats that exceed 16.3 ^{o}C maximum weekly average temperature declines significantly (Welsh *et al*. 2001).

Preferred rearing habitat has little or no turbidity and high sustained invertebrate forage production. 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. 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-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.

During late March and early April, coho salmon yearlings begin to smoltify and migrate downstream to the ocean. Out-migration usually peaks in mid-May, if conditions are favorable. Emigration timing is correlated with peak upwelling currents along the coast. Ocean entry at this time facilitates more growth and, therefore, greater marine survival (Holtby *et al*. 1990). At this point, the smolts are about 10 to 13 cm in length. After entering the ocean, the immature salmon initially remain in nearshore waters close to their parent stream. They gradually move northward, staying over the continental shelf (Brown *et al*. 1994). Although they can range widely in the north Pacific, the oceanic movements of California coho salmon are poorly understood.

The amount of time coho spend in estuarine environments is variable, but the time spent in estuaries may be less in the southern portion of their range (CDFG 2002). 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 (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. Nevertheless, estuarine residence times for radio tracked age 1+ coho smolts are often short, and can average 1 to 3 days (Miller and Sadro 2003).

Not all coho salmon migrate to estuaries as smolts. Miller and Sadro (2003) and Wallace (2006) report that a portion of young-of-the year (YOY) coho salmon juveniles move to estuaries during the spring months. Movement of YOY coho salmon has been attributed to displacement by high spring runoff, freshet events during fry emergence, or over-seeding and displacement of sub-dominant juveniles (Miller and Sadro 2003; Murphy *et al*. 1997). Information from Miller and

Sadro (2003) and Wallace (2006) shows that juvenile coho salmon movements and residency times in estuaries can be complex.

Some of the YOY coho salmon that moved to Oregon's Winchester Creek estuary in the spring were found to remain in the estuary to rear during the summer, and appeared to move further upstream in the estuary as the seasons changed. Miller and Sadro (2003) indicate that rising water temperatures and salinity may cause fish to move upstream in the summer, and higher flows may be responsible for YOY moving out of the estuary in the fall. Similarly, in California's Freshwater Creek, some YOY reared in the estuary during the summer, but they also appeared to move upstream when lower sloughs became saltwater in the late spring and summer (Wallace 2006). YOY coho salmon appeared to move upstream in both estuaries studied when salt content and temperatures rose to similar levels, making either or both reasonable explanations for the observed movements.

NMFS notes that some of the physical conditions in the estuaries discussed above are different in many ways from those in some other coastal California estuaries. For example, the Winchester Creek and Freshwater Creek estuaries are located on wide, flat floodplains with abundant wetlands and sloughs, whereas the Russian River is much more constrained by hillsides near its mouth and it has more limited marsh and slough habitats. Miller and Sadro (2003) indicate that the importance of estuarine rearing to coho salmon populations may be based on the amount of wetland and slough habitats present.

Coho salmon juveniles have been found in other estuaries in coastal California. Small numbers of YOY coho salmon have been found during the summer in the Redwood Creek estuary in Humboldt County in Northern California and in the Albion River estuary in Mendocino County (Maahs and Cannata 1998; S. Cannata, CDFG, personal communication, December 2004). Somewhat larger numbers of coho salmon YOY (roughly 1,000) have been found in Big Lagoon at the terminus of Redwood Creek in Marin County (Golden Gate National Recreation Area, 2008).

3. Steelhead

Steelhead spend anywhere from one to five years in saltwater, however, two to three years are most common (Busby *et al*. 1996). Some return as "half-pounders" that over-winter one season in freshwater before returning to the ocean in the spring. 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 (Barnhart 1986).

Only "winter" steelhead are found in the CCC steelhead ESU. 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 13 cm (Thompson 1972). 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 (Thompson 1972). Most spawning takes place from January through April. Steelhead may spawn more than one season before dying (iteroparity), in contrast to other species of the genus *Oncorhynchus*. Most

adult steelhead in a run are first time spawners, although Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (about 17 percent) in California streams. Among repeat spawners, the representation of each group declines as the number of spawnings increases. There is a sharp decline in numbers from second spawners (about 15 percent) to third spawners (about 2 percent). Fish spawning four or more times are rare (less than 1 percent).

Because rearing juvenile steelhead reside in freshwater all year, adequate flow and temperature are important to the population at all times. Generally, throughout their range in California, steelhead that are successful in surviving to adulthood spend at least two years in freshwater before emigrating downstream. Emigration appears to be more closely associated with size than age. 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. Smolts can range from 14-21 cm in length.

Steelhead spawn in cool, clear streams featuring suitable water depth, gravel size, and current velocity. Intermittent streams may be used for spawning (Everest 1973, Barnhart 1986). 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 intragravel velocities exceed 20 cm/hr (Coble 1961; Phillips and Campbell 1961). The number of days required for steelhead eggs to hatch is inversely proportional to water temperature and varies from about 19 days at 15.6^{o}C to about 80 days at 5.6^{o}C. Fry typically emerge from the gravel two to three weeks after hatching (Barnhart 1986).

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 (Meehan 1991). However, steelhead tend to use riffles and other habitats not strongly associated with cover more than other salmonids during summer rearing. 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, and their abilities to capture and metabolize food, and withstand disease (Barnhart 1986; Bjornn and Reiser 1991). Rearing steelhead juveniles prefer water temperatures of 7.2-14.4^{o}C and have an upper lethal limit of 23.9^{o}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 (Busby *et al*. 1996).

DO levels of 6.5-7.0 mg/l affect the migration and swimming performance of steelhead juveniles at all temperatures (Davis *et al*. 1963). 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. Low DO levels decrease juvenile steelhead swimming speed, growth rate, food consumption rate, efficiency of food utilization, threat avoidance behavior, and ultimately survival.

During rearing, suspended and deposited fine sediments can directly affect salmonids by abrading and clogging gills, and indirectly cause reduced feeding, avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat (Reiser and Bjornn 1979). 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 we assume this finding applies to steelhead as well.

The migration of juvenile steelhead to lagoons occurs throughout the year, but is concentrated in the late spring/early summer and in the late fall/early winter period (Zedonis 1992; Shapovalov and Taft 1954).

Two discrete groups of juvenile steelhead utilize different kinds of habitat provided by lagoons: steelhead juveniles that use coastal lagoons for freshwater rearing throughout the year, and smolts that drop down from the watershed and use the lagoon primarily in the spring prior to seawater entry. Juveniles, especially those of small size such as YOY, are unlikely to be able to survive for long periods of time in the salt water environments of estuaries that are open to the ocean. McCormick (1994) indicates that steelhead juveniles need to be 2+ in age (or 150 mm in size) to be able to withstand full seawater (35 ppt). Survival time increases with juvenile size and decreases with salt concentration. For example, YOY rainbow trout/steelhead (80 - 100 mm) exposed to 25 ppt salinity were able to survive for about 19 hours, while larger age 2+ steelhead/rainbow trout (150-200 mm) were unaffected for the duration of the experiment (Parry 1960).

Small steelhead juveniles are likely to avoid salt water and brackish environments, and while they can be acclimated to brackish water, their growth is likely hindered. In the Navarro River estuary north of the Russian River, steelhead juveniles segregated by size when the estuary was open to the ocean. YOY and age 1+ juveniles were found mostly in the upper areas of the estuary (a few were found in the middle area), where salinity in the surface layers remained lower and was less influenced by tidal action (Cannata 1998). In the Mattole River lagoon, juvenile movement to the upper areas of the lagoon in one year was attributed to substantial salt water overwash into the lower lagoon (Zedonis 1992). In Redwood Creek, the substantial decrease in steelhead numbers in the estuary following breaching was likely caused, in part, by the sudden shift from fresh to salt water (Larson 1987). Steelhead juveniles can be acclimated to different concentrations of salt water if done relatively slowly. Morgan and Iwama (1991) acclimated steelhead fry and juveniles to 4, 8, 12, and 16 ppt salinity by raising salinities 1-2 ppt per day with less than 5% mortality. Nevertheless, growth rates declined as salinity increased. Steelhead growth rates declined 16% over the range of salinities tested. The distribution of juveniles seen in the lagoons described above, and the avoidance of salt water by smaller juveniles indicates that acclimation, especially for YOY, is not the norm in tidally influenced (or overwashed) estuaries in Northern California.

Because rearing juvenile steelhead often migrate downstream in search of available freshwater habitat (Bjornn 1971), significant percentages of the juvenile steelhead population can end up rearing in coastal lagoons and estuaries (Zedonis 1992; Shapovalov and Taft 1954). If estuarine

or coastal lagoon rearing habitat is unavailable or of poor quality, the potential survival of these emigrants is low.

B. Species Viability Assessment

1. Species Legal Status

For the latest ESA status review of listed salmonids, NMFS formed Biological Review Teams (BRTs) comprised of a core group of scientists from the NMFS Northwest and Southwest Fisheries Science Centers, supplemented by experts on particular species from NMFS and other federal agencies. The BRTs assembled the best available information on the condition of listed salmonids and used a risk-matrix method to quantify risks faced by each ESU[14] based on the VSP concept (Good *et al*. 2005). This information was transformed into risk scores. Based on these risk scores (including interactions among different risks) each member of the BRT voted using a "likelihood point method" to distribute 10 points among three ESU risk categories: not at risk, likely to become endangered, or in danger of extinction (Good *et al*. 2005).

a. CC Chinook Salmon

Although there are limited data available, recent status reviews for CC Chinook salmon conclude that population abundance levels remain depressed relative to historical levels and that this ESU is "likely to become endangered" (NMFS 2001; Good *et al*. 2005). In the most recent status review, the BRTs evaluation of available data indicated moderately high risk in all VSP elements. The BRTs main concerns were the low abundance relative to historical abundance, potential loss of populations in the southern part of the ESU, and the loss of spring-run salmon in the Eel River and other areas. A majority (67%) of the BRTs votes for CC Chinook salmon were "likely to become endangered". Of the remainder, votes for "in danger of extinction" out numbered "not warranted" by two to one. NMFS issued a final rule maintaining the threatened status of CC Chinook salmon on June 28, 2005 (70 FR 37160).

b. CCC Coho Salmon

The BRTs evaluation of available data in the most recent status review indicated that CCC coho salmon are at very high risk of extinction because of conditions associated with the VSP categories of abundance, growth rate, and spatial structure. The BRT's main concerns were low abundance across the ESU, long term downward trends in abundance across the ESU, and extirpation of most populations in the southern two-thirds of the ESU. In addition, loss of genetic diversity from range reductions, loss of brood years, and historical hatchery influence were considered high concerns. A large majority (74%) of the BRT's votes for CCC coho salmon were "in danger of extinction" (Good *et al*. 2005). NMFS issued a final rule confirming the endangered status of CCC coho salmon on June 28, 2005 (70 FR 37160).

[14] Subsequent to the BRT's work, steelhead ESUs were re-evaluated as DPSs. This reevaluation did not result in listing status determinations different from the BRT's work.

c. CCC Steelhead

The BRT's evaluation of available data for CCC steelhead indicated abundance and productivity, as well as spatial structure, were relatively high concerns. A majority of the BRT's votes for CCC steelhead were "likely to become endangered" (69%) with 25% for "in danger of extinction". On January 5, 2006, NMFS issued a final determination that the CCC steelhead DPS is a threatened species, as previously listed (71 FR 834).

2. Factors Responsible for Species Status

a. Freshwater Habitat Degradation

The condition of freshwater habitats has been degraded from conditions known to support viable salmonid populations. NMFS has determined that present depressed population conditions are, in part, the result of the following human-induced factors affecting habitat (including critical habitat): logging, agricultural and mining activities, urbanization, stream channelization, dams, wetland loss, and water withdrawals, including unscreened diversions for irrigation. Impacts of concern include alteration of stream bank and channel morphology, alteration of water temperatures, loss of spawning and rearing habitat, fragmentation of habitat, loss of downstream recruitment of spawning gravels and large woody debris, degradation of water quality, removal of riparian vegetation resulting in increased stream bank erosion, increases in erosion entry to streams from upland areas, loss of shade (higher water temperatures) and loss of nutrient inputs (Busby *et al*. 1996; 69 FR 33102, 70 FR 52488). Depletion and storage of natural river and stream flows have drastically altered natural hydrologic cycles in many of the streams in the ESU. Alteration of flows have caused migration delays, loss of suitable habitat due to dewatering, stranding of fish from rapid flow fluctuations, entrainment of juveniles into poorly screened or unscreened diversions, and increased water temperatures harmful to salmonids.

b. Climate and Ocean.

As described in the **Introduction**, the best available scientific information indicates that the Earth's climate is warming, driven by the accumulation of greenhouse gasses in the atmosphere (Lindley *et al.* 2007; Battin *et al.* 2007; Oreskes 2004). Our climate influences freshwater streams and the oceans. Warming is likely to affect many of the physical, chemical, and biological conditions of these water bodies[15]. Because salmon and steelhead depend upon freshwater streams and oceans during different stages of their life history cycle, their populations are likely to be impacted by climate change.

Beyond the scientific consensus that warming is occurring, predicting what is likely to happen, and when, involves uncertainty. Predictions become less and less certain as one moves from the global scale to regional and smaller scales, and less certain as models attempt to predict far into the future (50 to100+ years). In addition to increasing uncertainty as geographical scale decreases and length of time increases, there is less certainty about changes to the ocean

[15] There is strong evidence that warming has already affected ecosystems. See for example Walther *et al*. 2002, Harvell *et al*. 2002, Schneider and Root 2002, and Quinn and Adams 1996.

environment than for terrestrial environments such as freshwater streams (Climate Impacts Group [CIG] 2004).

Several complex climate models are now being used to forecast future climate conditions. Model predictions show relatively low to relatively high impacts depending upon which model is used and which greenhouse gas emissions scenario is considered. Regardless, even the relatively low impact results from most models of low emissions scenarios indicate changes in temperatures, rainfall, snowpack, vegetation, *etc.* by mid to late century that are likely to have serious negative impacts on salmonid population numbers, distribution, and reproduction.

In California, average summer air temperatures are expected to increase (Lindley *et al*. 2007). Heat waves are expected to occur more often, and heat wave temperatures are anticipated to be higher (Hayhoe *et al.* 2004). The snowpack is expected to decrease, potentially as much as 60 to 80% by the end of the century (Luers *et al.* 2006). Total precipitation in California may decline; critically dry years may increase (Lindley *et al*. 2007; Schneider 2007). Wildfires are expected to increase in frequency and magnitude, by as much as 55% under the highest emission scenarios modeled (Luers *et al.* 2006). Vegetative cover may also change, with decreases in evergreen conifer forest and increases in grasslands and mixed evergreen forests. Forest productivity is also expected to decline (Luers *et al.* 2006).

These changes are likely to further degrade habitat for salmon and steelhead in the North Central California Coast Recovery Domain[16]. Air temperature is an important influence on stream temperature (Poole and Berman 2001). Increasing air temperatures have the potential to limit the quality and availability of summer rearing habitat for salmonids in streams. For example, modeling reported by Lindley *et al.* (2007) shows that as overall warming increases from 2° C under lower greenhouse gas emission scenarios, to 8°C under high emissions scenarios, the geographic area experiencing mean August air temperature exceeding 25°C moves further into coastal drainages and closer to the Pacific Ocean. Stream temperatures will likely increase in these areas.

The likely amount of rainfall in Coastal California under various warming scenarios is less certain, although as noted above, total rainfall across the state is expected to decline. For the California North Coast, some models show large increases (75% to 200%) while other models show decreases of 15% to 30 % (Hayhoe *et al.* 2004). In the interior, precipitation is expected to decrease (Bell 2004). Increases in rainfall during the winter have the potential to increase scour and loss of salmon and steelhead redds. Reductions in precipitation will likely lower flows in streams during the spring and summer, likely reducing the availability of flows to support smolt migration to the ocean and the availability of summer rearing habitat.

The link between fires and sediment delivery to streams is well known (Wells 1987; Spittler 2005). Fires can increase the incidence of erosion by removing vegetative cover from steep slopes. Subsequent rainstorms produce debris flows which carry sediments to streams.

[16] Recovery Domains are part of NMFS' recovery planning process. Each recovery planning domain encompasses a specific geographic area and has a Technical Recovery Team (Scientists from NMFS, other Federal agencies, State agencies, and academia). NMFS Recovery Coordinators lead the development of recovery plans for each domain. Domains typically encompass more than one ESU or DPS.

Increases in stream sediment can reduce egg to emergence survival, and can reduce stream invertebrate production, an important food source for rearing salmon and steelhead juveniles (Bjornn and Reiser 1991; Waters 1995)

Changes in vegetative cover can impact salmon and steelhead habitat by reducing stream shade (thereby promoting higher stream temperatures), and changing the amount and characteristics of woody debris in streams. High quality salmonid habitat in many salmonid streams in the northern part of the NCCC Domain is dependent upon the recruitment of large conifer trees to streams. Once these trees fall into streams, their trunks and root balls provide hiding cover for salmonids and, by interacting with stream flows and stream beds and banks, often create deep stream pools needed by salmonids to escape high summer water temperatures. For coho salmon, these pools are essential for feeding and rearing.

Ocean changes resulting from climate change are more uncertain (CIG 2004). Global warming may impact coastal upwelling along the California Coast in the NCCC Domain by decreasing early upwelling and increasing mid and late upwelling. (Diffenbaugh *et al.* 2003). Weak early season upwelling can have serious consequences for the marine food web, impacting invertebrates, birds, and potentially other biota (Barth *et al.* 2007). Salmon and steelhead smolts entering these California Coastal waters could be impacted by reduced food supplies.

Estuaries are likely to become increasingly vulnerable to eutrophication (excessive nutrient loading and subsequent depletion of oxygen) due to changes in precipitation and freshwater runoff patterns, temperatures, and sea level (Scavia *et al.* 2002). These changes can affect water residence time, dilution, vertical stratification, water temperature ranges, and salinity. Salinities in San Francisco Bay have already increased because increasing air temperatures have led to earlier snow melt, reducing freshwater flows in the spring. Should this trend continue and strengthen, salinities during the dry season will increase, contributing additional stress to an ecosystem that is already highly altered and degraded (Scavia *et al.* 2002).

Thus, habitat conditions for salmonids in the ESU's and DPS under consideration in this biological opinion are likely to worsen by mid to late century. Reliable predictions of specific levels of impacts, or localized impacts, during the fifteen year period of the proposed action cannot currently be made based on the best available scientific information.

Global climate change has likely already had some impacts on salmonids and their habitats on the west coast of the United States. For example, changes in water temperature and Sockeye salmon spawning times in the Columbia River have been attributed to global climate change (Quinn and Adams 1996). Similar information is not available for the rivers and streams in the ESUs and DPS under consideration in this biological opinion. We assume any climate change impacts that have occurred are generally reflected in the current status of listed species and their critical habitats.

Variability in ocean productivity has been shown to affect salmon production both positively and negatively. Beamish and Bouillion (1993) showed a strong correlation between North Pacific salmon production and marine environmental factors from 1925 to 1989. Beamish *et al.* (1997) noted decadal-scale changes in the production of Fraser River sockeye salmon that they

attributed to changes in the productivity of the marine environment. They also reported the dramatic change in marine conditions occurring in 1976-77 (an El Niño year), when an oceanic warming trend began. These El Niño conditions, which occur every three to five years, negatively affect ocean productivity. Johnson (1988) noted increased adult mortality and decreased average size for Oregon Chinook salmon and coho salmon during the strong 1982-83 El Niño. Of greatest importance is not how these species perform during periods of high marine survival, but how prolonged periods of poor marine survival affect the viability of populations. It is reasonable to assume that salmon populations have persisted over time, under pristine conditions, through many such cycles in the past. But it is less certain how they will fare in periods of poor ocean survival when their freshwater, estuary, and nearshore marine habitats are degraded (Good *et al*. 2005).

As noted above, dramatic declines in coho salmon and Chinook salmon adult returns for 2006/07 are likely the result of poor ocean conditions. Due to their low numbers, some coho salmon populations may not be resilient enough to survive extended periods of exceptionally low ocean productivity.

c. Artificial Propagation

Releasing large numbers of hatchery fish can pose threats to salmonid stocks through genetic impacts, competition for food and other resources, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs are primarily caused by the straying of genetically distinct hatchery fish and the subsequent hybridization of hatchery and wild fish. Artificial propagation threatens the genetic integrity and diversity that protect overall productivity against changes in the environment (61 FR 56138).

d. Reduced Marine-Derived Nutrient Transport

Reduction of marine-derived nutrients (MDN) to watersheds is a consequence of the past century of decline in salmon abundance (Gresh *et al.* 2000). MDN are nutrients that are accumulated in the biomass of salmonids while they are in the ocean and are then transported to their freshwater spawning sites. Salmonids may play a critical role in sustaining the quality of habitats essential to the survival of their own species. MDN (from salmon carcasses) has been shown to be vital for the growth of juvenile salmonids (Bilby *et al*. 1996; Bilby *et al*. 1998). The return of salmonids to rivers can make a significant contribution to the flora and fauna of both terrestrial and riverine ecosystems (Gresh *et al.* 2000). Evidence of the role of MDN and energy in ecosystems suggests this deficit may result in an ecosystem failure contributing to the downward spiral of salmonid abundance (Bilby *et al*. 1996). The loss of this nutrient source may perpetuate salmonid declines in an increasing synergistic fashion.

e. Marine Mammal Predation

Predation by marine mammals is not believed to be a major factor contributing to the decline of west coast salmon relative to the effects of fishing, habitat degradation, and hatchery practices. Harbor seal (*Phoca vitulina*) and California sea lion (*Zalophus californianus*) numbers have

increased along the Pacific Coast (NMFS 1999a). However, at the mouth of the Russian River in Sonoma County for example, Hanson (1993) reported foraging behavior of California sea lions and harbor seals with respect to anadromous salmonids was minimal. Hanson (1993) also stated predation on salmonids appeared to be coincidental with the salmonid migrations, and that the harbor seal population at the mouth of the Russian River was not dependent upon them. Nevertheless, this type of predation may have substantial impacts in localized areas.

3. Method for Determining Current Species Extinction Risk

One prerequisite for predicting the effects of a proposed action on a species is understanding the species extinction risk, and the mechanisms by which the proposed action is expected to affect this risk. As described above in the analytical framework, we equate high extinction risk with a low likelihood of survival and recovery, and vice versa. To determine the current extinction risk for CC Chinook salmon, CCC coho salmon, and CCC steelhead, we used the historic population structure of these species as presented by the Technical Recovery Team (TRT) for the North-Central California Coast Recovery Domain in Bjorkstedt *et al.* (2005), the VSP concept, and ESU viability criteria provided by the TRT in Spence *et al*. (2008).

The TRT analyzed the historical population structure of salmon and steelhead ESUs or DPSs to develop an understanding of the population dynamics that supported these species prior to European settlement. The TRT intends the historical condition of the salmonid populations in each ESU or DPS to serve as a point of reference for evaluating the current viability (extinction risk)[17]. Bjorkstedt *et al*. (2005) described the demographic structure of each ESU and DPS within the North–Central California Coast Recovery Domain (NCCCRD). Distinct historical populations were defined as those individuals that spawn and rear in a single watershed that is tributary to the Pacific Ocean. Larger basins were further subdivided into multiple populations if sufficient physical, behavioral, or selective barriers to effective dispersal were evident. This model of geographically explicit populations was supported by information on geographic structure, genetic structure, and life history variation.

These historical populations were further categorized by Bjorkstedt *et al.* (2005) based on their distribution and demographic role (*i.e.*, independent, dependent, or ephemeral). Functionally independent populations were sufficiently large to be viable in isolation, and had a high likelihood of persisting over a 100 year timescale, absent human impacts (*i.e.*, a negligible extinction risk). Potentially independent populations were potentially viable in isolation, but were likely influenced by immigrants from adjacent populations. Dependent populations were unlikely to persist over a 100 year time period in isolation, but with immigration from other nearby populations, their risk of extinction is reduced. .Ephemeral populations were unlikely to persist for a 100 year time period and did not receive enough immigration to reduce this risk. These populations were only intermittently present.

Bjorkstedt *et al.* (2005) arranged the historical populations in each ESU or DPS into diversity strata to provide a diversity and spatial structure framework to evaluate ESU viability (extinction risk). These diversity strata represent groups of populations that are located in generally similar

[17] The TRT did not propose that historical conditions are the criteria or benchmark for evaluating population or ESU viability (extinction risk).

sets of environmental conditions within an ESU, and the populations within diversity strata are expected by Bjorkstedt *et al.* (2005) to reflect these conditions phenotypically and genotypically. Groups of populations spread out across an ESU help to ensure viability by "*buffer*[ing] *the ESU against catastrophic loss of populations by ensuring redundancy,* provid[ing] *sufficient connectivity among populations to maintain long-term demographic and evolutionary processes, and ensur*[ing] *sufficient genetic and phenotypic diversity to maintain the ESUs evolutionary potential in the face of changing environmental conditions*" (Spence *et al.* 2008).

Spence *et al*. (2008) provide a set of rules to address the ESU viability issues identified above. In order for an ESU or DPS to be viable, *i.e*., have a negligible extinction risk, representation, redundancy, and connectivity criteria should be met:

Representation Criteria

1a. All diversity strata that include historical functionally independent (or potentially independent) populations within an ESU or DPS should be represented by populations with viable populations (populations with negligible extinction risk) for the ESU or DPS to be considered viable (having negligible extinction risk).

2a. Within each diversity stratum, all extant phenotypic diversity (*i.e*., major life history types) should be represented by viable populations (populations with negligible extinction risk).

Redundancy and Connectivity Criteria

2a. At least fifty percent of historically independent (or potentially independent) populations in each diversity stratum must be demonstrated to be at low risk of extinction. For strata with three or fewer independent populations, at least two must be viable (have a negligible risk of extinction).

2b. Within each diversity stratum, the total aggregate abundance of independent populations selected to satisfy 2a above must meet or exceed fifty percent of the aggregate viable population abundance (provided by Spence *et al*. 2008) for all independent and potentially independent populations in the ESU.

3. Remaining populations, including historical dependent populations and any historical independent and potentially independent populations not expected to attain a viable status must exhibit occupancy patterns consistent with those expected under sufficient immigration subsidy arising from the 'core' independent populations selected to satisfy the criteria above.

4. The distribution of extant populations, regardless of historical status, must maintain connectivity within the diversity stratum, as well as connectivity to neighboring diversity strata.

We evaluated the current extinction risk for CC Chinook salmon, CCC coho salmon, and CCC steelhead (Figure 4) by examining the extinction risk for each population within each diversity strata (as defined by Spence *et al.* 2008- Figure 5) for these ESUs or DPS. With the results of this analysis, we then used the ESU level criteria above to determine the ESU and DPS

extinction risk. Our analysis of extinction risk at the ESU/DPS scale relies heavily on the work of Spence *et al.* 2008.

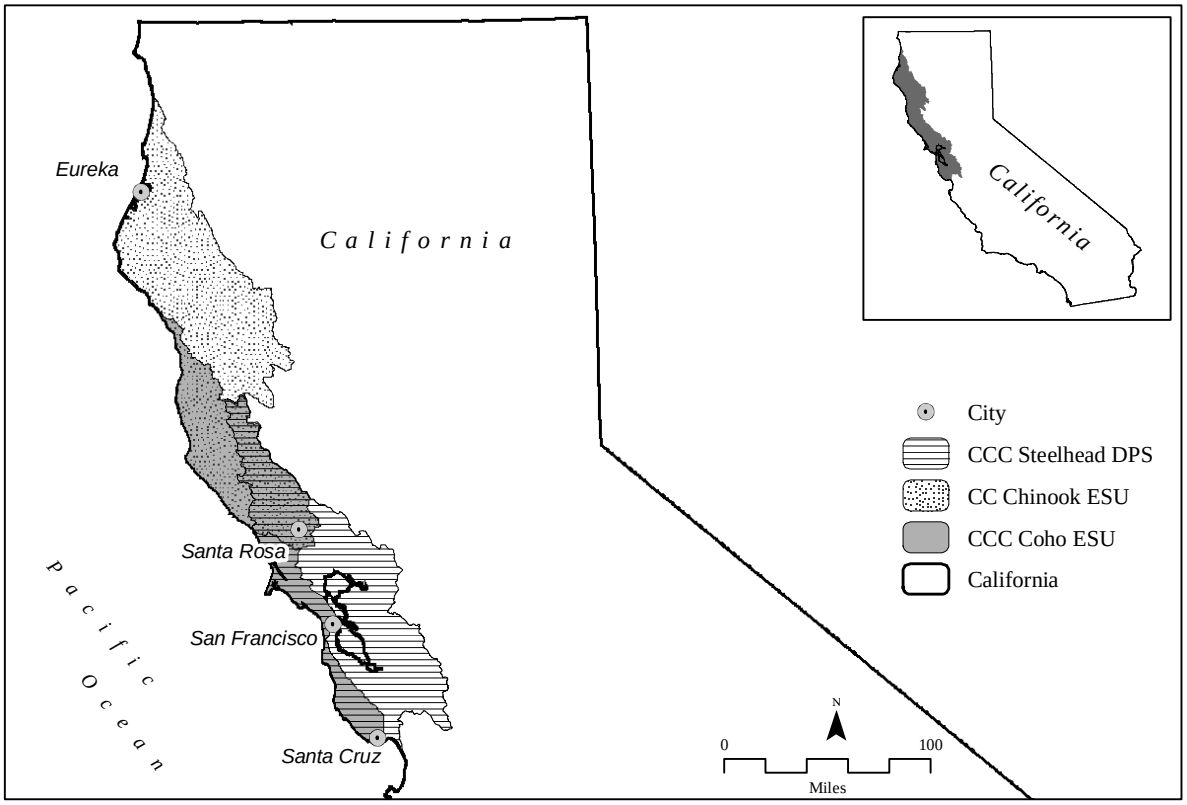

Figure 4. Location of the CC Chinook salmon ESU, the CCC coho salmon ESU, and the CCC steelhead DPS along the coast of California.

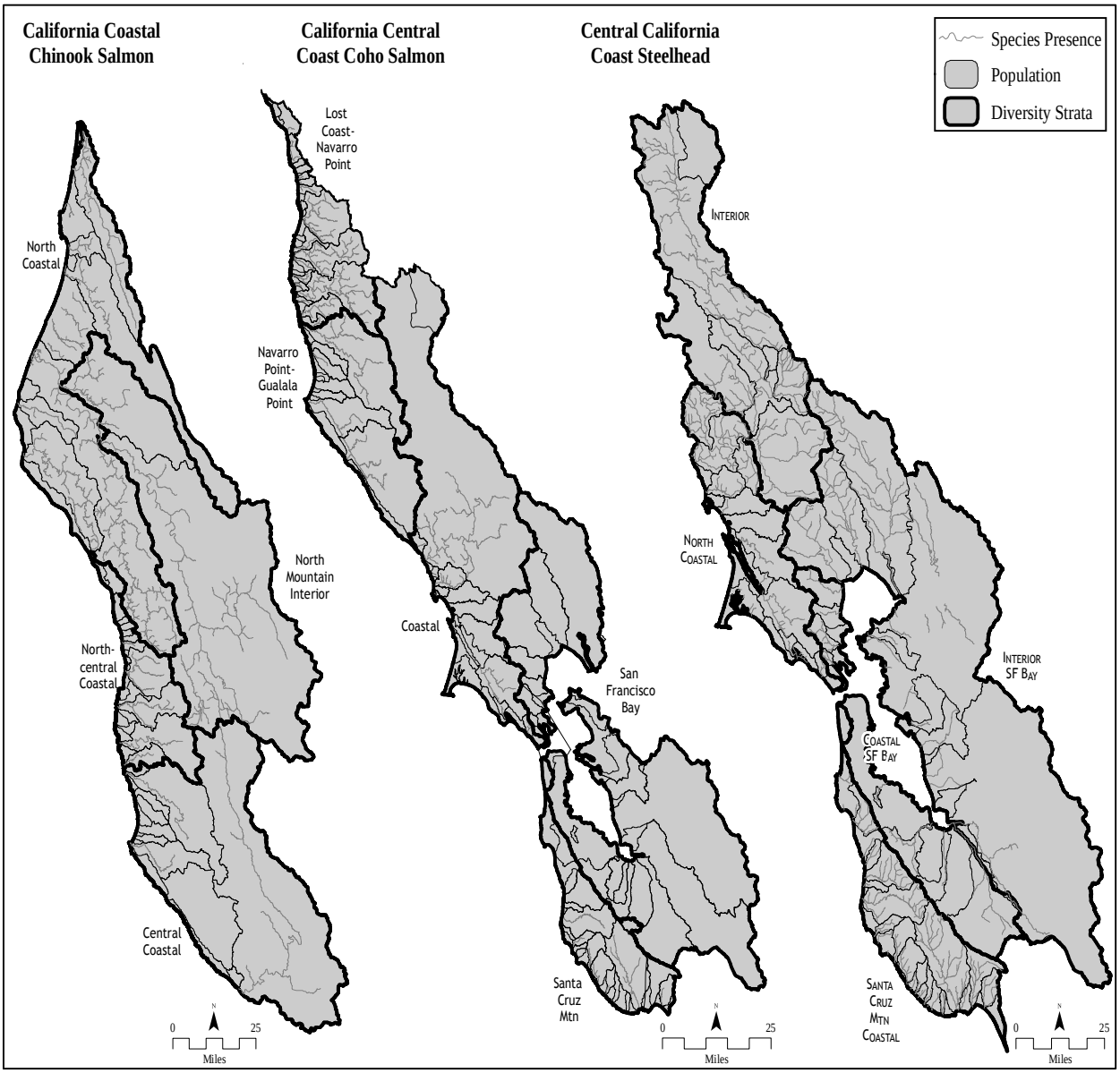

Figure 5. ESU/DPS maps of CC Chinook salmon, CCC coho salmon, and CCC steelhead showing their range, current distribution, and historical population structure. CC Chinook salmon diversity strata are for Fall-Run populations only. Figure based on Spence *et al.* 2008.

Note that our analysis in the draft June 11, 2007 biological opinion applied the VSP criteria to strata directly. In that earlier analysis, information on the general status of the species in the watersheds within the strata was used to determine strata viability (*i.e*. extinction risk). For this final biological opinion we recast our analysis to focus more on the extinction risk of individual populations in each diversity strata in order to appropriately apply the ESU viability criteria provided by Spence *et al*. (2008). As noted above, we rely heavily on the results of Spence *et al*. (2008) as the definitive source for ESU viability evaluation. We do this because Spence *et al*. (2008) is the work of the TRT and provides the best available scientific information.

Our analysis of the viability of the populations that make up each strata in each ESU or DPS used the four population viability criteria described in McElhany *et al.* (2000): abundance, population growth rate, spatial structure, and diversity. Abundance is defined as the estimated number of spawning adults in a given year in a population. Population growth rate is defined as a population's ability to replace itself given its intrinsic reproductive rate in the context of its environment. Spatial structure concerns the geographic distribution of a population at any life stage. Consideration was given to the loss of a population's ability to support certain life stages, such as spawning and rearing, even if the species was still considered present (*e.g.*, the area functions as a migration corridor). Diversity is defined as the genetic, morphologic, physiological, behavioral, or ecological variation that exists within a population. We assumed that the trajectory of these evolutionary traits is influenced by the environmental conditions that impose a selective regime on the population. Since the actual genetic and other forms of diversity were often unknown, the diversity of habitats and their divergence from historical conditions were at times, used as a surrogate.

4. CC Chinook Salmon Extinction Risk

CC Chinook salmon is the only species with a population that Bjorkstedt *et al*. (2005) split between two diversity strata. One of the sub-populations (South Fork Eel River) in the Lower Eel River population was placed in the North Coastal Diversity Stratum because this subpopulation experiences conditions environmentally similar to other populations in this stratum. Spence *et al.* (2008) maintained this split.

a. North Coastal Diversity Stratum Populations

Adult abundance is substantially reduced from historic levels and the Spring-run populations are extinct in this stratum (Bjorkstedt *et al*. 2005, Good *et al*. 2005). For these reasons, we consider the populations in the North Coastal stratum to have very high extinction risk. However, the northern latitude, coastal climate, and generally wetter condition tend to provide high potential for favorable conditions for the survival of these populations, though anthropogenic disturbance detracts from this potential. In addition, the populations in this stratum remain widely distributed and, with the exception of a spring-run component, probably maintain much of their genetic diversity. Also, recent data (prior to 2007) indicates a moderate short-term increase in adult abundance (Good *et al*. 2005).

b. North Mountain Interior Diversity Stratum Populations

The populations in this stratum have very high extinction risk, due mainly to the status of the Upper Eel River population. It, along with the Lower Eel River population (also part of the North Coastal Diversity Stratum), was historically one of the largest in the ESU and functioned as an important source population (Bjorkstedt et al. 2005). The Upper Eel River population is also particularly important to the conservation of the ESU because it possesses unique geographic and ecologic features that have likely fostered adaptations not provided for in most other habitats in the ESU. In particular, it contains most of the high altitude areas where snowmelt contributes substantially to stream flows. This provides cooler and more abundant stream flows later into, and perhaps throughout, the summer. These conditions have historically

allowed for the persistence of a spring-run population. However, spring-run Chinook salmon are also considered extinct in the populations that make up this diversity stratum (Good *et al.* 2005). The area occupied by the Upper Eel River population is characterized by long migration routes which may have selected for a unique component of the fall run population.

c. North-Central Coastal Diversity Stratum Populations

There is some question as to whether historical populations existed within this diversity stratum. Most anecdotal evidence indicates Chinook salmon have been absent from the major rivers in this stratum since at least the early twentieth century (A. Grass, CDFG, personal communication, October 25, 2006). However, an analysis of habitat potential conducted by Bjorkstedt *et al*. (2005) indicates these same rivers possess the necessary size, gradient, and flow to have supported viable populations. In terms of evaluating extinction risk, we find it prudent to assume the later analysis is correct and to rate the current extinction risk in the context of assumed historical populations.

We consider the populations in this stratum to have very high extinction risk, based primarily on the low observed abundance in the context of presumed historical population abundances. This suggests declines in the abundance and productivity of these populations. Some habitat attributes, however, are favorable for the populations in this stratum due to the dominant influence of the coastal climate.

d. Central Coastal Diversity Stratum Populations

Our assessment of the extinction risk of the populations in this stratum is greatly influenced by the observed adult abundance and inferred productivity of the Chinook salmon population in the Russian River. SCWA estimated the Chinook salmon run size at 1,500 in 2000 and 2001, and observed 5,474 in 2002, 6,103 in 2003, 4,788 in 2004[18] 2,572 in 2005, 3,410 in 2006, and 1,959 in 2007 (Chase *et al*. 2005, www.scwa.ca.gov/ environment/natural_resources/ Chinook_ salmon.php, SCWA 2008c). The apparent increase in abundance is tempered by the 2007 decline in this, and other, Chinook populations across the State. Recent information on Chinook salmon adult returns for 2007 indicates low returns likely due to poor ocean conditions and other factors (SWFSC 2008). In the Russian River, returns for 2007 are estimated at 1,959 fish, down from 3,410 fish in 2006 and a high of 6,081 fish in 2003 (SCWA 2008c). This species has also been observed recently in the Navarro and Gualala rivers, but sightings are uncommon and we believe the species occurs only sporadically in these latter basins. In this stratum, only one independent population appears to remain, but the moderate abundance in the Russian River population may suggest a trend toward sustainable production for this population.

e. ESU Extinction Risk

The CC Chinook Salmon ESU appears to contain only one population (the Russian River population) that may be trending toward viability. All other populations are substantially reduced from historical levels. Both the North- Central Coastal and Central Coast Diversity Stratum are poorly represented in terms of functionally independent populations (and dependent

[18] Estimates are based on partial counts of adult fish passage at the Wohler Dam fish ladder.

populations); only the Russian River population appears to remain in the Central Coast Diversity Stratum. As described below in **C. Critical Habitat Analysis**, CC Chinook salmon critical habitat does not currently support the conservation of the species. The degraded conditions of PCEs limit the ability of many Chinook salmon populations to increase in abundance, and may foster further declines in some areas. We conclude that this ESU is at an elevated risk of extinction. Spence *et al.* (2008) reach similar conclusions:

"*In summary, the lack of data from which to assess viability of extant populations in the northern part of the ESU, the apparent lack of extant populations, with the exception of the Russian River, in the southern half of the ESU, the loss of important life history diversity (i.e., spring-run populations), and the substantial gaps in the distribution of Chinook salmon throughout the CC ESU strongly indicate that this ESU fails to meet low-risk criteria and is therefore at elevated risk of extinction*" (Spence *et al.* 2008).

5. <u>CCC Coho Salmon Extinction Risk</u>

This is the only ESU of the three we analyze that is listed as endangered, and the results of the extinction risk assessment reflect that special status. While the populations in the Lost Coast-Navarro Point diversity stratum rated better than the populations in the other four strata, we still consider these populations reduced from a viable state given their current status. The viability of the populations within the ESU generally follow a trend of increasing extinction risk in a southerly direction. The populations in the Santa Cruz Mountains Diversity stratum have the highest extinction risk outside of the populations of the San Francisco bay stratum, which are presumed extinct. With the exception of Lagunitas Creek in Marin County, the distribution and abundance of coho salmon in watersheds south of Big Salmon Creek is very limited.

The populations in this ESU suffer from extremely low contemporary abundance compared to historical abundance, widespread local extinctions, clear downward trends in abundance, extensive habitat degradation, and associated decreases in carrying capacity (Good *et al*. 2005). Both juvenile density and presence-absence data suggest that coho salmon continue to decline across the ESU (NMFS 2001). These low numbers reduce the resilience of CCC coho salmon populations to respond to changes in ocean conditions and other climatic factors. Preliminary data from adult return counts and estimations in 2007/08 indicates a severe decline in returning adults across the range of coho salmon on the coast of California and Oregon compared to the same cohort in 2004/05. Ocean conditions are suspected as the principal short term cause because of the wide geographic range of declines (Southwest Fisheries Science Center 2008). This year's cohort has not been detected in Redwood Creek (in Marin County), suggesting this cohort may be extirpated in this stream.

a. Lost Coast-Navarro Point Diversity Stratum Populations

The extinction risk of populations in this stratum, while better than most others in the ESU, appears to be increased by consistent declines in abundance and reductions in distribution of rearing habitats. However, given the poor status of populations to the south, the greater amount of precipitation and more consistent influence of cool coastal climate, it is likely that this stratum contains the majority of coho salmon remaining in the ESU. Historical time series estimates of

spawner abundance for three major rivers in the area (Ten Mile River, Noyo River, and Big River) show substantial reductions from 1963 to 1991 (Table 5) (Good *et al*. 2005). While the accuracy of these early abundance estimates is somewhat suspect due to the lack scientific rigor, they are indicative of a general decline. More sophisticated adult abundance estimates based on redd counts by Gallagher (2005) suggest that depressed abundance continues to the present day.

Table 5. Recent historical estimates of coho salmon spawner abundance for functionally independent populations in the Lost Coast-Navarro Point diversity stratum of the CCC coho salmon ESU. Table adapted from Good *et al*. (2005).

Functionally Independent Population	CDFG (1965) 1963	Wahle and Pearson (1987) 1984-1985	Brown *et al*. (1994) 1987-1991	% Reduction
Ten Mile River	6000	2000	160	97
Noyo River	6000	2000	3740	38
Big River	6000	2000	280	95

The limited ability of populations to successfully spawn, rear, and therefore reproduce may be the proximal cause of the decline in their abundance. Juvenile data from the Noyo River indicate strong year-classes in 1995, 1996 (this year was strong coastwide), and 1997. More recent data however, suggests that these strong years did not carry over to subsequent generations (NMFS 2001).

The spatial structure of rearing juvenile populations in this stratum is likely moderately reduced from historical condition. Usal Creek was historically one of the northern most populations in the ESU and is now considered extinct (NMFS 2001). Coho salmon populations persist in Cottoneva, Pudding, Hare, Caspar, Little River, Albion, and Big Salmon watersheds (CDFG 2002). Additional occupancy data suggest that populations also continue to persist in Big, Noyo, and Ten Mile rivers but that their distributions have been substantially reduced within those basins (Good *et al*. 2005). We therefore consider the populations within this diversity stratum to have a moderate risk of extinction.

b. Lost Coast-Gualala Point Diversity Stratum Populations

There is a pronounced increase in extinction risk for the populations in the Navarro Point-Gualala Point diversity stratum relative to the populations in the stratum to the north. Evidence suggests that abundance and distribution of coho salmon populations in this area is greatly reduced from historical levels. Historically, the functionally independent populations in this stratum were found in the Navarro, Garcia, and Gualala rivers. Currently, the Navarro River is the only watershed to support persistent, albeit limited, areas of rearing coho salmon. Good *et al*.'s (2005) data show substantial reductions in abundance from 1963 to 1991 (Table 6).

Most of the Navarro River was occupied at one time (Spence *et al*. 2005). Johnson *et al*. (2002) estimated 130 stream miles in the Navarro River supported coho salmon as of 1963. The current distribution of coho salmon in the Navarro watershed is now primarily limited to the North Fork

and Flynn Creek (CDFG 2002; Johnson *et al*. 2002). Johnson *et al*. (2002) estimated a 78 percent reduction in the distribution of rearing coho salmon within the Navarro River watershed over the previous 12 year period. CDFG (2002) reports that annual surveys conducted since 1989 have detected coho presence only in the South Fork Garcia River and only in 1994 and 1996.

There are also isolated occurrences of coho salmon in the North Fork of the Gualala River. Limited surveys in the Gualala River have documented occasional occurrence of coho in the last 15 years, but the distribution of fish has been sparse. NMFS (2001) reported that coho were present in the Little North Fork Gualala River in 1988, but have not been documented since, despite being surveyed in 9 of the 12 years prior to 2001. For these reasons, we consider the extinction risk of the historically functionally independent populations in this stratum to be high.

Table 6. Recent historical estimates of coho salmon spawner abundance for functionally independent populations in the Navarro Point-Point Arena diversity stratum of the CCC coho salmon ESU. Table adapted from Good *et al*. (2005). Percent reductions were calculated using Wahle and Pearson (1987) estimates only when Brown *et al*. (1994) estimates were not available.

	CDFG (1965)	**Wahle and Pearson (1987)**	**Brown *et al*. (1994)**	
Watershed	**1963**	**1984-1985**	**1987-1991**	**%Reduction**
Navarro River	7000	2000	300	96
Garcia River	2000	500	-	75
Gualala River	4000	1000	200	95
Other	10000	7000	470	95

c. Coastal Diversity Stratum Populations

Current abundance of coho salmon populations is highly variable within this diversity stratum. The Lagunitas Creek population (functionally independent) has the most persistent and abundant population in the strata. Redwood Creek and Pine Gulch populations also appear to remain persistent. Coho salmon in the Russian River population (functionally independent) have declined to a population that is very nearly extirpated (Table 7). Those few fish that remain spawn and rear in select tributary reaches. Many of these tributaries, however, are occupied intermittently or have not supported coho salmon at all in recent years. The Russian River is unique in that it is the location of a captive broodstock program that supports recovery of the coho salmon population within the Russian River basin. The program to date, has successfully produced, reared, and released four year classes of juvenile coho salmon, and two of the year classes have reached an age sufficient to yield returning adult spawners. Spawning survey efforts by RRCSCBP in the best habitat areas, detected only one adult female in the 2006/07 spawning season, and no adult coho salmon were detected during the 2007/08 spawning season (M. Obedzinski, U.C.Davis Extension, personal communication, 2008)[19]. However, during spring 2008, downstream migrant trapping data documented more than 500 wild spawned coho

[19] This female was observed in Mill Creek and was later found dead and unspawned. Video monitoring of adult escapement in Austin Creek also yielded a possible lone female, but its identification to species is unconfirmed due to image quality.

salmon YOY in Felta Creek, a watershed where broodstock fry have been planted annually since 2004 (J.L.Conrad, PSMFC, personal communication, May 21, 2008).

NMFS (2001) reports an overall decline in abundance in coho salmon populations in Marin County based on juvenile surveys through 2000. A minimum of 86 adult coho salmon have, on average, spawned annually in Olema Creek (a Lagunitas Creek tributary) over the last eight years. Ettlinger *et al*. (2006) reported observations of 679 adult coho salmon in Lagunitas Creek, and 190 redds for the 2005/06 spawning season. Expansions from redd counts led to an estimated 630 coho salmon adults. As noted above, adult returns are further reduced for 2007/08. In Lagunitas Creek, initial reports indicate returns are down by almost 80% (SWFSC 2008).

Table 7. Recent historical estimates of coho salmon spawner abundance for populations in the Coastal diversity stratum of the CCC coho salmon ESU. Table adapted from Good *et al*. (2005). While these early abundance estimates are hampered by very limited data, they are indicative of a general decline.

Population	CDFG (1965) 1963	Wahle and Pearson (1987) 1984-1985	Brown *et al*. (1994) 1987-1991	% reduction
Russian River	5000	1000	255	95
Other-Sonoma	1000	-	180	80
Other-Marin	5000	-	435	91

Coho salmon populations were historically widely distributed in the streams of this stratum (Spence *et al*. 2005), but have since suffered substantial range restriction (Good *et al*. 2005). For example, coho salmon once reared in the headwaters of the Russian River, which is approximately 100 miles inland from the coast. Despite many survey efforts, they are currently detected in only a few tributaries in the lower, western portion of the watershed, and are nearly extirpated. With the exception of some Marin County streams, the distribution of populations is highly fragmented throughout the streams of this stratum. Coho salmon populations were extirpated in Sonoma County's Salmon Creek and Marin County's Walker Creek, although the RRCSCBP has successfully reintroduced a small spawning population of coho salmon into Walker Creek (CDFG, unpublished data).

Genetic analysis of fish from both Green Valley Creek and Dutch Bill Creek in the Russian River provide evidence of recent population bottlenecks, indicating that they were derived from just a few breeding individuals (Bjorkstedt *et al*. 2005). This lack of genetic variation represents reduced diversity within the population and is suggestive of increased extinction risk.

The overall viability of populations in this stratum is poor. The Russian River population alone was once the largest and most dominant source population in the ESU. The fact that it is now on the verge of extirpation suggests not only a high risk of extinction for this population, but for other nearby populations in this ESU. The historical role of the Russian River population highlights the importance of this population to the survival and recovery of the species.

d. San Francisco Bay Diversity Stratum Populations

Coho salmon populations in this stratum are presumed extinct. NMFS (2001) based this conclusion on the absence of positive detections (Brown *et al*. 1994; CDFG 2002; Good *et al*. 2005) and widespread elimination of habitat.

CDFG (2002) summarized the status of coho salmon in San Francisco Bay tributaries as follows: Leidy (1999) conducted fisheries surveys on 79 Bay Area streams between 1992 and 1998, and coho salmon were not observed in any of the surveys. The last known observation of coho salmon was in 1981. Leidy and Becker (2001) consequently determined that coho salmon populations are now extinct in San Francisco Bay tributaries.

e. Santa Cruz Mountains Diversity Stratum Populations

The populations in this diversity stratum have the highest risk of extinction of populations in any extant coho salmon stratum primarily due to extremely low abundances, loss and fragmentation of historical spawning and rearing habitats, and loss of year-classes. In 1965, CDFG estimated the annual run size in the San Lorenzo River (historically a functionally independent population) to be 1600 adults (Table 8). In 1989, 183 adults were documented in the San Lorenzo River (Brown *et al*. 1994). Fifty adult spawners (mostly marked hatchery fish) were observed during the 2004-05 spawning season (Brian Spence, unpublished data). Table 8 indicates substantial reductions in adult populations between 1963 and 1991 (Good *et al*. 2005).

Table 8. Recent historical estimates of coho salmon spawner abundance for populations in the Santa Cruz Mountains diversity stratum of the CCC coho salmon ESU. Table adapted from Good *et al*. (2005). Percent reductions were calculated using Wahle and Pearson (1987) estimates only when Brown *et al*. (1994) estimates were not available. While the accuracy of these early abundance estimates is hampered by limited scientific data, they are indicative of a general decline.

Streams or Population	CDFG (1965) 1963	Wahle and Pearson (1987) 1984-1985	Brown *et al*. (1994) 1987-1991	% Reduction
Santa Cruz Co. Streams	1500	50	-	97
San Lorenzo River	1600	500	183	89

In the San Lorenzo River, annual summer surveys failed to produce evidence of successful reproduction by coho salmon from 1994 to 2004. But planting of hatchery smolts into Pescadero Creek (another historically functionally independent population) in the spring of 2003 apparently resulted in successful reproduction in the 2004-05 spawning season.

Coho salmon populations were likely present historically in the Tunitas, San Gregorio, Pescadero, Gazos, Waddell, Scott, San Vicente, San Lorenzo, Soquel, and Aptos watersheds

(Brown *et al*. 1994, Spence *et al*. 2005). Populations in this portion of the range of CCC coho salmon have suffered substantial reductions in range (Good *et al*. 2005).

Spence *et al*. (2005) report confirmed presence historically throughout most of the San Lorenzo watershed, including Boulder Creek, Fall Creek, Zayante Creek, and Bean Creek. Though the watershed had been systematically surveyed since 1998, no juvenile coho salmon had been observed since 1981 (Alley 2006). Two adult coho salmon were observed in the watershed in 2005 (Alley and Associates 2005). However, the presence of a viable population remains questionable based on the low numbers observed. This population is likely extinct.

The populations in Gazos, Waddell, and Scott creeks remain in low abundance, but coho salmon distribution in each watershed is variable by year with some year classes almost entirely absent (Smith 2006). Juvenile coho salmon have also recently been observed in San Vicente and Laguna Creeks (J. Ambrose, NMFS, personal communication, October, 2006)

The NMFS status review updates for coho salmon (NMFS 2001; Good *et al*. 2005) concluded in general that the likelihood of coho salmon being present decreased from 1989 to 2000, and that this trend was more pronounced in the southern part of the range where extirpation or near extirpation of the ESUs populations has occurred.

Given the generally low abundance, apparent negative trend in population growth rate, reduced and fragmented distribution, and compromises to diversity, the populations that remain in this stratum have a high risk of extinction.

f. ESU Extinction Risk

CCC coho salmon face the highest risk of extinction of any of the three species considered in this biological opinion. This is evidenced primarily by their precipitous decline in abundance during the last several decades and poor status of population viability metrics in general. The cause of this decline is likely from the widespread degradation of habitat, particularly those habitat attributes that support the freshwater rearing life-stages of the species as described below in **C. Critical Habitat Analysis**. The loss of this habitat and the concurrent extirpation of local populations have resulted in a high degree of isolation for the populations that remain. None of the Spence *et al.* (2008) ESU viability criteria are met. We conclude that this ESU is not presently viable and currently faces a high risk of extinction. Spence *et al.* (2008) reach similar conclusions:

"*In summary, the lack of demonstrably viable populations (or lack of data from which to assess viability) in any of the strata, the lack of redundancy in viable populations in any of the strata, and the substantial gaps in the distribution of coho salmon throughout the CCC ESU strongly indicate that this ESU is currently in danger of extinction*".

6. CCC Steelhead Extinction Risk

Our extinction risk analysis for steelhead is based on anadromous *O. mykiss* only. While resident *O. mykiss* likely interbreed with anadromous forms in some circumstances, we assume this to be a minor component of the DPSs populations (Bjorkstedt *et al*. 2005).

The extinction risk of CCC steelhead is influenced by their life history diversity, which tends to buffer population responses to adverse environmental variation in several ways. For example, the highly variable time of instream residence and spawning age allow for effective temporal dispersal within a population. This reduces the susceptibility of a cohort to extinction by reducing the proportion of the population exposed to temporally limited adverse conditions (*e.g.*, critically dry years). Temporal dispersion therefore acts to maintain population viability in the face of environmental variability (Bjorkstedt *et al*. 2005). This unique strategy may have helped steelhead avoid the recent downturns in numbers seen in Chinook salmon and coho salmon populations in 2007/08. For example, steelhead returns to Russian River fish facilities do not reflect the low numbers seen in coho salmon and Chinook salmon populations (Jeffry Jahn, NMFS, personal communication, 3-4-08). Another adaptive advantage is that individual adult steelhead are able to spawn in multiple years, unlike coho and Chinook salmon that die shortly after spawning.

a. Interior Diversity Stratum Populations

Six populations[20] comprise the Interior Diversity Stratum all of which are within the Russian River watershed. We have assessed their abundance to be substantially reduced from historical abundance, but persistent. The growth rates of these populations appear moderately negative as indicated by a long-term decrease in abundance (SEC 1996). The Upper Russian River population (historically functionally independent) has lost 21 percent of its historic potential habitat to CVD and the distribution of the Dry Creek population (historically potentially independent) has been reduced by 56 percent by the installation of WSD alone (Brian Spence, NMFS, personal communication, March 8, 2007). We therefore consider the distribution of some steelhead populations in this stratum to be substantially reduced from historical condition. Additional disruption of the remaining habitat has likely further reduced the other populations in this stratum as well.

In addition, some loss of genetic diversity in these populations is apparent from genetic analyses and is attributed to previous among-basin transfers of stock and intense local hatchery production (Bjorkstedt *et al*. 2005). We also assume some loss of diversity from the reduction in, and degradation of, habitat.

While steelhead populations appear to be reduced in abundance and experience loss of genetic diversity in this stratum, they remain persistent and widespread below major barriers such as WSD and CVD. Given the reductions in key viability criteria, we consider the extinction risk of populations in this stratum to be moderate.

[20] The Middle Russian River and Sausal populations are actually groups of very small dependent populations that inhabit minor tributaries to the middle reach of the Russian River.

b. North Coastal Diversity Stratum Populations

The North Coastal diversity stratum is composed of three populations in the lower Russian River[21], and nine coastal populations immediately south of the Russian River. Most populations in this stratum, along with the populations in the Interior and Santa Cruz Mountains diversity strata, are at high risk of extinction because evidence suggests their population metrics have been compromised. Population abundance varies from zero in Estero Americano and Stemple Creeks, to fairly abundant in Lagunitas Creek. The Russian River populations are probably less than 15 percent of what they were 30 years ago (Good *et al*. 2005). We conclude that steelhead have been extirpated from Americano Creek and Stemple Creek based on: 1) the Bjorkstedt *et al*. (2005) determination that populations existed historically in these watersheds; and 2) there is no evidence of current presence in these watersheds (NMFS 2005*b*). However, steelhead populations, although often substantially reduced in number, remain widely distributed outside of these two areas.

c. Coastal and Interior SF Bay Diversity Strata Populations

The two San Francisco Bay diversity strata share the populations with the highest extinction risk ratings of the DPS. Overall abundance is exceptionally low, with even the healthiest remaining populations, Sonoma Creek and Napa River (both historically functionally independent) far below historical abundance. For example, the Napa River is the largest watershed in the northern San Francisco Bay (426 square miles), and has 48 major tributaries; this watershed is estimated to have historically supported an annual spawning run of 6,000 to 8,000 steelhead (Leidy *et al*. 2005). At present, the steelhead run is believed to be less than a few hundred adults (Stillwater Sciences 2002). Many tributaries of San Francisco Bay have lost the ability to support spawning and rearing habitat due to ongoing urban and agricultural developments. This suggests, in combination with the declines in abundance, a negative growth rate for populations in these strata.

Historical populations existed in almost every watershed tributary to San Francisco and San Pablo Bays (Leidy *et al*. 2003; Bjorkstedt *et al*. 2005), but now they are extirpated from many streams, and those streams that remain occupied frequently have reduced distributions within them (Leidy *et al*. 2005). This has led to a highly fragmented distribution overall, particularly in the East and South bay areas. Reduced population size, reduced distribution, and severe alteration of habitat conditions have all likely led to loss of diversity, both genetic and ecologic.

d. Santa Cruz Mountains Diversity Stratum Populations

The San Lorenzo River historically had one of the largest functionally independent populations in the ESU. Run sizes in that river have been reduced by 85 percent of what they were just 30 years ago. This pattern is also evident in other populations in the stratum (Good *et al*. 2005). For example, analysis of juvenile data for the San Lorenzo, Scott (historically functionally independent), Waddell (historically potentially functionally independent), and Gazos watershed

[21] The Lower Russian River population is actually a group of very small dependent populations that inhabit minor tributaries to the lower Russian River and we lump them into one for convenience.

(historically dependent) populations by Good *et al*. (2005), indicate declines in juvenile populations consistent with the more general estimates of declining abundance in the region.

The populations in this stratum have a high risk of extinction. We consider abundance to be substantially reduced from historical levels, and the population growth rate to be negative based on observed long-term declines in abundance. Spatial structure and diversity remain in fairly good condition, although their distribution is somewhat reduced and fragmented.

e. DPS Extinction Risk

As described below in **C. Critical Habitat Analysis,** CCC steelhead habitat is degraded throughout the DPS, especially in the San Francisco Bay tributaries. However, their diverse life-history strategy has helped to improve their likelihood of viability overall, relative to CCC coho salmon and CC Chinook salmon. The life-history factor is reflected in their widespread distribution, and lack of spatial isolation, in three of the five diversity strata. However, because viable populations do not clearly appear in any strata, and the *Coastal and Interior SF Bay Diversity Strata* appear to have widespread population extirpations, we rate this DPS as having medium risk of extinction. Spence *et al.* (2008) arrive at similar conclusions:

"*The presence of dams that block access to substantial amounts of historical habitat (particularly in the east and southeast portions of San Francisco Bay), coupled with ancillary data … that suggest that it is highly unlikely that the Interior San Francisco Bay strata has any viable populations, or that [DPS] redundancy criteria would be met. Elsewhere in the [DPS], the lack of demonstrably viable populations remains a significant concern.*

C. Critical Habitat Status

To assess the proposed action's effects on critical habitat, we must determine whether, with implementation of the proposed action, critical habitat would remain functional (or retain the current ability for the primary constituent elements to be functionally established) to serve the intended conservation role for the species.

The primary purpose of this section is to identify the current function of critical habitats within the ESU or DPS of each species to support the intended conservation role for each species. Such information is important for an adverse modification analysis because it establishes the context for the evaluation of any effects to habitat that the proposed action may have on critical habitat. We begin by considering the current quantity, quality and distribution of each Primary Constituent Element (PCE) of critical habitat (migration, spawning, rearing, and estuarine), or essential habitat features, for each species. To fully understand the conservation role of these habitats, however, we identify the specific habitat attributes (*e.g*., pool depth, water temperature, complex cover, *etc*.) needed by individual life-stages. This provides us with the necessary link between habitat and the conservation of the species by defining the role and quality of habitat necessary to sustain the species life history cycle.

Linking habitat to the salmonid life stages that it supports also facilitates the secondary purpose of this analysis, which is to identify factors threatening to further deteriorate salmonid critical

habitat. In this portion of the critical habitat analysis we consider the factors responsible for the existing habitat conditions. This information was used in the preceding species viability assessments.

When it designated critical habitat for steelhead and Chinook salmon, NMFS developed a list of PCEs specific to these species (NMFS 2005*a*). These PCEs include sites essential to support one or more of the life stages of the species to which it applies (*i.e.*, sites for spawning, rearing, migration and foraging). These sites in turn contain physical or biological features essential to the conservation of the species (for example, spawning gravels, water quality and quantity, side channels, forage species). Specific types of sites and the features associated with them include, but are not limited to the following:

1. Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

2. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development.

3. Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

4. Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

NMFS developed a similar list of species habitat requirements and essential features (PCEs) for CCC coho salmon (64 FR 24049):

1. Juvenile summer and winter rearing areas,

2. Juvenile migration corridors,

3. Areas for growth and development to adulthood,

4. Adult migration corridors, and

5. Spawning areas.

Within these areas, essential features of coho salmon critical habitat include adequate: (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) safe passage conditions.

In this section, and throughout this biological opinion, we use the term PCE to refer to the essential habitat features for all three species under consideration. To help clarify the role of PCEs, we identified specific habitat attributes of each PCE that were most influential in determining the current condition of the PCE to support each life-stage. For example, we identified pool area and depth as one habitat attribute within the freshwater rearing PCE that is a measure of the quality of rearing habitat for YOY steelhead through the summer and into the fall season.

1. Ranking Method

We developed a qualitative method for evaluating the condition of each habitat attribute in terms of its current condition relative to its role and function in the conservation of the species. We chose to evaluate the current condition of critical habitat at the diversity stratum level to facilitate our species viability assessment which follows. Diversity strata are groups of salmonid populations that share similar environmental and ecological background conditions. For example, salmonid populations in interior watersheds likely experience higher stream temperatures than coastal populations due to natural climatic factors. Human impacts may or may not exacerbate these conditions.

By characterizing the general condition of a given habitat attribute across each diversity stratum as either: good, fair, inadequate, or poor, we were able judge how each habitat attribute is able to generally support specific life stages within the stratum, and thereby identify specific conditions likely to be affecting the current abundance, growth rate, distribution, and diversity of each population in the stratum. Once we determined the current condition of PCE attributes in each stratum, we used this information to draw conclusions about the current ability of critical habitat to support the conservation of each species at the ESU or DPS level. This information is then used in the **Integration and Synthesis** and **Reasonable and Prudent Alternative** sections to understand the significance of any project-related changes to habitat in terms of how those changes are likely to affect the conservation role and function of the PCEs of critical habitat for each species.

We began the ranking process by defining four habitat condition classes. We described a habitat attribute as “good” when evidence suggested the current condition was conducive to high survival from one salmonid life stage to the next. In the absence of any other factors limiting the population, a “good” condition would allow for some population growth given a species current abundance. A “fair” rated habitat attribute indicates that within the subject watersheds, the condition of the habitat attribute probably does not currently limit most populations; however, conditions for that attribute are degraded for many populations and they may contribute to limiting some populations or subpopulations. An “inadequate” habitat condition indicates limited functional habitat for that life stage such that the PCE of critical habitat has a strong potential to limit many or most populations. A “poor” rating indicates severely limited amounts of functional habitat for that PCE in that diversity strata.

It is important to note that the standard of "good" habitat we use for this analysis is not directly comparable to properly functioning condition as used in NMFS (1999). In that document, properly functioning condition is defined as the sustained presence of natural habitat-forming processes (*e.g.*, riparian community succession, bedload transport, precipitation runoff pattern, channel migration) that are necessary for the long-term survival of the species through the full range of environmental variation. Our definition emphasizes the current condition of habitat in terms of how it supports the biological requirements of the species at this time; though we do assume this condition will persist for the next 15 years in the absence of any additional perturbation. We have not evaluated the geophysical processes responsible for these habitat formations, and do not intend to imply that "good" habitat is sufficient to support a fully recovered population into the foreseeable future.

We also acknowledge that these habitat rankings are generalizations and that actual conditions may substantially vary spatially within a diversity stratum, and seasonally (*e.g.*, dependent on precipitation and available surface water). The rankings therefore take these considerations into account and describe habitat performance overall. For example, pool area and depth may be rated as "fair" in a given diversity stratum, which would imply that, across the landscape, this habitat attribute may limit some populations during the summer rearing life stage. In dry years, and in some areas, pools may be more limiting, and in wet years they may be less limiting, but in general the condition of this habitat attribute averages out to be "fair". Attribute rankings for each diversity stratum were compiled by NMFS staff based on local staff knowledge of watershed conditions, review of watershed reports such as Total Maximum Daily Load (TMDL) listings, GIS map data on passage barriers, and other sources of information.

2. CC Chinook Salmon

Unlike the two species that follow, habitat attributes for rearing CC Chinook salmon were rarely rated "poor" or "inadequate". Poor conditions, where they exist, are spread across multiple life stages and are not always consistent among diversity strata. The only PCE with all "good" or "fair" ratings across strata is adult migration, suggesting that, in the absence of other factors, migration corridors for Chinook salmon are generally sufficient to promote some population growth.

a. North Coastal Diversity Stratum

Estuarine rearing quality is the only habitat attribute rated as inadequate or poor, and thus the availability of good quality estuarine habitat may be a factor limiting population growth in this stratum (Table 9). There are, however, several habitat attributes that are degraded and may limit some populations or subpopulations (*i.e.*, rated fair). These include upstream passage, spawning gravel quality, redd scour, availability of rearing habitat, water temperature, and predation. These conditions suggest that chronic habitat degradation affecting multiple attributes is responsible for the low population abundances seen in this stratum, rather than impairment of a single habitat attribute. Nonetheless, estuarine habitats may play an influential role in the mix of factors, especially considering the importance of estuaries in the life cycle of the species and the habitat's vulnerability to anthropogenic impacts.

The dominant land use in this stratum is timber harvest, although urbanization, rural development, and exploitation of coastal resources (*e.g.*, fishing) are also prevalent. Estuarine habitats have been reduced in size and degraded by over 100 years of flood control, encroachment, and harbor developments. In addition, increased sedimentation from landscape disturbances upstream have resulted in aggraded channels and estuaries, particularly in the Eel River.

b. North Mountain Interior Diversity Stratum

This stratum has the only "poor" ratings, and the most "inadequate" ratings in the ESU, suggesting that habitat conditions are worse here than in other diversity strata. Aside from inadequate habitat for YOY to rear in briefly before their downstream migration, all other potentially limiting habitats involve the migration of juveniles to the ocean. These poor conditions are driven primarily by the loss of flows behind Van Arsdale and Scott dams upstream. The loss of flows to the lower main stem of the Middle Fork Eel River creates a thermal barrier each summer as flows pass through the hot inland canyon. This barrier impedes the downstream migration of juvenile Chinook salmon in early summer and significantly increases juvenile mortality, particularly in dry and normal water years. The introduction and subsequent success of pikeminnow (*Ptychocheilus grandis*) into this system has added another stressor to Chinook salmon smolts. As warm-water tolerant predators of smolts, they likely have a substantial impact on smolt mortality.

c. North-Central Coastal Diversity Stratum

This stratum is the only one in the ESU to have no "poor" or "inadequate" ratings associated with it, indicating that, in general, habitat conditions should favor the maintenance of Chinook salmon populations. This assessment however, does not comport with results of the viability analysis which indicates depressed populations. It is possible that a "fair" rating may be too generous for adult migration flows. Given the early fall run timing and small watershed size (and correspondingly smaller discharges), combined with timing of rainfall events, conditions for successful migration may not be as consistent as is immediately evident.

This stratum is comprised almost entirely of forested landscape, and timber harvest is therefore the dominant land use. Coastal and rural developments also prevail. Sedimentation from timber harvest (past and present) likely affects many of the habitat attributes for this species.

d. Central Coastal Diversity Stratum

Spawning gravel quality is the lowest rated habitat attribute in this stratum. The main stem channels of the three major rivers in the stratum (Navarro, Gualala, and Russian rivers), where the majority of spawning habitat occurs, are all impacted by the intrusion of fine sediment into spawning gravels, but for different reasons. The banks of the Navarro River are destabilized in many areas from removal of riparian vegetation and other disturbances associated with grazing; agriculture and forestry also likely increase sedimentation, but to a lesser extent. Historical timber harvest is likely the primary source of sedimentation in the Gualala River, although roads

and rural development may also be a contributing factor. Flow releases from CVD have been shown to extend the duration of turbid flow events beyond what would occur naturally and at levels harmful to juvenile salmonids (Ritter and Brown 1971, Newcombe and Jensen 1996). This is likely a primary source of sedimentation in the Russian River as well, and combines with sedimentation associated with active agricultural lands, rangeland, and rural development to create high fine sediment loads in the watershed.

Table 9. PCEs of CC Chinook Salmon critical habitat divided into habitat attributes specific to supporting the life-cycle of this species. Habitat attribute condition ratings are applied as defined above. We place NA in habitat attribute cells not utilized by this species due to their unique life history.

PCE	Life Stage	Habitat Attribute	North Coastal	North Mountain Interior	North Central Coastal	Central Coastal
Migration	Adult (fertile)	Access to Watershed	Good	Good	Good	Fair
Migration	Adult (fertile)	Instream Passage (Barriers)	Fair	Fair	Good	Fair
Migration	Adult (fertile)	Migration Flows	Good	Fair	Fair	Good
Spawning	Incubating Eggs	Amount of Spawn Gravel	Good	Good	Good	Good
Spawning	Incubating Eggs	Distribution of Spawn Gravel	Good	Good	Good	Fair
Spawning	Emergent Fry	Spawn Gravel Quality	Fair	Fair	Fair	Inadequate
Spawning	Emergent Fry	Amount of Redd Scour	Fair	Fair	Good	Fair
Rearing	Summer YOY	Proximity to Redds	Fair	Inadequate	Fair	Fair
Rearing	Parr	Complexity/cover	NA	NA	NA	NA
Rearing	Parr	Pool area and depth	NA	NA	NA	NA
Rearing	Parr	Water Temperatures	Fair	Poor	Good	Good
Rearing	Parr	Stream Flow	NA	NA	NA	NA
Estuarine	Parr and Smolt	Rearing Quality	Inadequate	Inadequate	Fair	Fair
Rearing	Parr (winter)	Velocity Refuge	NA	NA	NA	NA
Migration	Smolt	Migration Flows	Good	Poor	Good	Good
Migration	Smolt	Instream Passage (Barriers)	Good	Good	Good	Good
	Adult	Ocean Condition	Fair	Fair	Fair	Fair

e. The ESU -- CC Chinook Salmon Critical Habitat

Although all diversity strata in this ESU possess some PCE attributes rated as good or fair, some PCE attributes are rated as inadequate or poor in each strata. As we defined it, a rating of good suggests the attribute promotes some population growth. However, we do not equate a rating of good with fully supporting the conservation of a species. Thus, the relatively large number of fair and inadequate PCE attribute ratings is a clear indication that PCEs of critical habitat in the CC Chinook salmon ESU, while not as degraded as those in other ESUs described below, are either not currently functioning, and/or have been degraded in their ability to establish the functions necessary to serve their intended role to conserve the species.

3. CCC Coho Salmon

Our assessment of habitat for this species shows a distinct trend of increasing degradation as one progresses southerly through the species range, with the Lost Coast – Navarro Point Diversity Stratum (LC-NP) supporting most of the more favorable habitats and the Santa Cruz Mountains stratum supporting the least (Table 10). There also appears to be a concentration of poor and inadequate habitat conditions associated with the rearing PCE across all strata, which suggests the condition of rearing habitat is likely continuing to erode species abundance across its range. This hypothesis is consistent with published research that identifies freshwater rearing habitat as the primary limiting factor for other coho salmon populations (Quinn and Peterson 1996).

a. Santa Cruz Mountains Diversity Stratum

The Santa Cruz Mountains stratum has more poor habitat ratings than any other strata. More specifically, nearly every habitat attribute related to summer rearing is rated as poor. Poor or inadequate habitat conditions also exist for spawning gravel quality and the amount of redd scour. The only attributes rated as good are within the migration PCE (access to watershed and instream passage barriers - for both adults and smolts). This suggests that juvenile rearing PCE is continuing to reduce coho salmon abundance in this diversity stratum.

The degradation of rearing PCE in the Santa Cruz Mountains stratum is a result of the combined effect of land use practices on a terrain that is predisposed to erosion and sedimentation. The substrate in this region is sand dominated, which tends to produce spawning substrate high in fine particles, and spawning beds susceptible to scour from flood events. These conditions are easily exacerbated by anthropogenic watershed disturbances. This region has experienced widespread agricultural, rural, and urban developments, such as road development, which have likely contributed to this type of habitat degradation. Other sources of degradation include historic removal of LWD, water diversions, and stream channelization associated with flood control projects.

b. San Francisco Bay Diversity Stratum

We did not complete a PCE attribute by PCE attribute ranking analysis for this area. However, the lack of species presence now and general habitat analysis in this stratum indicates that PCEs of critical habitat in this stratum are generally likely to be in inadequate or poor condition.

Table 10. PCEs of CCC coho salmon critical habitat divided into habitat attributes specific to supporting the life-cycle of this species. Habitat attribute condition ratings are applied as defined above.

PCE	Life Stage	Habitat Attribute	LC-NP	NP-GP	Coastal	SC Mtns.
Migration	Adult (fertile)	Access to Watershed	Good	Fair	Fair	Fair
Migration	Adult (fertile)	Instream Passage (Barriers)	Fair	Fair	Fair	Fair
Migration	Adult (fertile)	Migration Flows	Good	Good	Fair	Fair
Spawning	Incubating Eggs	Amount of Spawn Gravel	Fair	Fair	Fair	Fair
Spawning	Incubating Eggs	Distribution of Spawn Gravel	Fair	Fair	Fair	Fair
Spawning	Emergent Fry	Spawn Gravel Quality	Fair	Fair	Inadequate	Poor
Spawning	Emergent Fry	Amount of Redd Scour	Good	Good	Fair	Inadequate
Rearing	Summer YOY	Proximity to Redds	Good	Good	Fair	Fair
Rearing	Parr	Complexity/cover	Fair	Inadequate	Inadequate	Poor
Rearing	Parr	Pool area and depth	Inadequate	Inadequate	Inadequate	Poor
Rearing	Parr	Water Temperatures	Inadequate	Poor	Poor	Poor
Rearing	Parr	Stream Flow	Good	Inadequate	Poor	Poor
Estuarine	Parr and Smolt	Rearing Quality	Fair	Fair	Inadequate	Inadequate
Rearing	Parr (winter)	Velocity Refuge	Inadequate	Inadequate	Inadequate	Inadequate
Migration	Smolt	Migration Flows	Good	Fair	Fair	Fair
Migration	Smolt	Instream Passage (Barriers)	Good	Good	Good	Good
	Adult	Ocean Condition	Fair	Fair	Fair	Fair

c. Coastal Diversity Stratum

Ratings for habitat attributes for the Coastal diversity stratum also indicate critical habitat is degraded, though not as severely as in the Santa Cruz Mountains stratum. Again, there is a concentration of poor conditions associated with the rearing PCE, although inadequate ratings appear in spawning and migration PCEs as well.

The inadequate rating for spawning gravel quality is influenced by increased sedimentation associated with agricultural, rangeland, and rural developments. A similar rating for velocity refuge is indicative of widespread channelization and stream simplification, particularly in the Russian River. Degraded rearing habitat conditions are likely a consequence of water withdrawals, sedimentation, disturbance to riparian vegetation, and channel modifications.

d. Navarro Point – Gualala Point Diversity Stratum

The pattern of degraded rearing PCEs continues within this stratum. Migration and spawning PCEs, although rated better than the strata to the south, remain only able to support current low population abundances. This region, more so than the previous strata, is dominated by forestry and rangeland land uses, which are likely the cause of increased sedimentation and degraded riparian conditions that impair rearing habitats.

e. Lost Coast – Navarro Point Diversity Stratum

In this stratum, pool area and depth, velocity refuge, and stream temperature were rated as inadequate, indicating that these habitat factors are probably the most likely to be limiting population growth of coho salmon. Other attributes were generally rated higher, although spawning gravel, and estuarine rearing habitat, were rated fair indicating that conditions are degraded and may limit populations in some locations.

More than any other stratum in the ESU, this region is dominated by a forested landscape. Timber harvest has been, and continues to be, the dominant land use in the area. Typical impacts from this activity include: increased rates of sedimentation, reduced riparian shading, and reduced recruitment of large woody debris in streams. Stream management in the form of active removal of woody debris, historical damming of rivers, and other forms of channel modification have also contributed to these conditions.

f. The ESU-- CCC Coho Salmon Critical Habitat

As described above, the current condition of PCEs of CCC coho salmon critical habitat indicates they are not currently functioning, and/or have had substantial degradation in their ability to establish the functions necessary to serve their intended role to conserve the species. Juvenile rearing habitat is particularly degraded, and this degradation occurs across the entire ESU. The current condition of PCEs for CCC coho salmon is likely to result in continued decline in the abundance, population growth rates, distribution, and diversity of this species.

4. CCC Steelhead

Our assessment of critical habitat for this species shows degraded conditions spread throughout the DPS. The degraded habitat primarily involves estuarine and rearing PCEs, but also occurs in other PCEs, depending on location (Table 11). Habitat in San Francisco Bay and its tributaries is most impaired, followed by the upper Russian River. Whereas, those watersheds most influenced by coastal climate tend to have habitat that is least impaired.

a. Interior Diversity Stratum

Six of seventeen habitat attributes in this diversity stratum were rated less than fair, yet no attributes were rated as poor. This suggests that population growth may be limited by many factors rather than one or just a few. Inadequate habitat attribute ratings apply to all PCEs except for adult migration. Spawning gravel quality is likely degraded by widespread sedimentation from roads and agriculture. The availability of transitional rearing habitat for newly emerged fry is likely impacted by channel modifications and the chronic deposition of fine sediments in edge-water habitats in the main stem due to turbid releases from CVD. Stream desiccation is likely the result of intensive groundwater pumping in this semi-arid region. Inadequate velocity refuge for over-winter rearing is due to various channel simplification actions, such as removal of LWD. Estuary conditions will be discussed separately below.

b. North Coastal Diversity Stratum

Three of seventeen habitat attributes are rated less than fair, and none are rated as poor. Ten of the seventeen habitat attributes received a fair rating which, by definition, suggests those habitats are degraded and may be limiting some populations at their current levels. Given the population status described below for this stratum, the preponderance of fair ratings should not be interpreted as a positive indication of habitat condition. Spawning gravel quality and stream desiccation, and estuary condition appear to be the most degraded PCE attributes limiting production for this diversity stratum.

Degraded spawning gravel quality is likely the result of widespread sedimentation associated with farming, grazing, and rural road developments. Watersheds likely to be most affected by this are Green Valley Creek, Salmon Creek, Estero Americano, Stemple Creek, and Walker Creek. Stream desiccation is related to intensive groundwater pumping and other water uses associated with agricultural, rangeland, and residential developments.

c. Santa Cruz Mountains Diversity Stratum

This diversity stratum has two habitat attributes rated as inadequate, none as poor, and six rated as good. As with the previous strata, habitat degradation seems to be spread among all PCEs and is of a chronic nature.

Table 11. PCEs of CCC steelhead critical habitat divided into habitat attributes specific to supporting the life-cycle of this species. Habitat attribute condition ratings are applied as defined above.

PCE	Life Stage	Habitat Attribute	Interior	North Coastal	SC Mtns.	Coastal SF Bay	Interior SF Bay
Migration	Adult (fertile)	Access to Watershed	Good	Good	Good	Good	Fair
Migration	Adult (fertile)	Instream Passage (Barriers)	Fair	Fair	Good	Poor	Poor
Migration	Adult (fertile)	Migration Flows	Fair	Good	Fair	Fair	Poor
Spawning	Incubating Eggs	Amount of Spawn Gravel	Good	Fair	Good	Poor	Fair
Spawning	Incubating Eggs	Distribution of Spawn Gravel	Good	Fair	Good	Fair	Fair
Spawning	Emergent Fry	Spawn Gravel Quality	Inadequate	Inadequate	Fair	Poor	Fair
Spawning	Emergent Fry	Amount of Redd Scour	Good	Good	Inadequate	Fair	Good
Rearing	Summer YOY	Proximity to Redds	Inadequate	Fair	Good	Inadequate	Inadequate
Rearing	Parr	Complexity/cover	Fair	Fair	Fair	Inadequate	Poor
Rearing	Parr	Pool area and depth	Fair	Fair	Fair	Fair	Fair
Rearing	Parr	Water Temperatures	Fair	Fair	Fair	Fair	Fair
Rearing	Parr	Stream Flow	Inadequate	Inadequate	Fair	Fair	Fair
Estuarine	Parr and Smolt	Rearing Quality	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate
Rearing	Parr (winter)	Velocity Refuge	Inadequate	Fair	Fair	Fair	Poor
Migration	Smolt	Migration Flows	Inadequate	Fair	Fair	Fair	Fair
Migration	Smolt	Instream Passage (Barriers)	Good	Good	Good	Good	Good
	Adult	Ocean Condition	Fair	Fair	Fair	Fair	Fair

The redd scour attribute is rated as inadequate primarily because the parent geology of this area is sandstone, which results in sand dominated stream substrates and increased susceptibility to erosion and streambed mobility. Agricultural and urban developments have exacerbated erosion and have therefore contributed to the degraded condition of this attribute. Most of the attributes rated as fair are related to rearing PCEs, which suggests rearing habitat in general may be limiting population growth in some populations.

d. Coastal and Interior SF Bay Strata

These diversity strata have the most poor and inadequate habitat attributes, and the least good ratings of any other strata. The same trend of chronic degradation spread across multiple PCEs is apparent here, but is taken to an extreme not observed elsewhere. Adult migration is impaired by barriers and altered flow conditions; spawning and egg incubation are limited by the amount and quality of spawning gravels; transitional rearing habitat for fry, and lack of channel complexity and cover limit the juvenile rearing life stage in both summer and winter. The role of estuary habitat in supporting these populations is also greatly altered as discussed below.

e. Estuarine PCE

We single out the estuarine PCE for discussion because it is the only habitat that we ranked as inadequate in supporting steelhead populations across all strata in the DPS. Estuaries constitute highly variable, large scale ecotones[22] in which salmonids rear in and pass through as smolts and as returning adults. Passage and rearing of juveniles in estuarine habitats is thought to be an integral phase of salmonid life history at a time when physiological adaptation, foraging, and refugia from predators are critical (Healey 1982; Simenstad *et al*. 1982). Occupation and utilization of estuarine habitats contributes to the fitness of juvenile salmonids preparing for survival at sea (Kotyk *et al*. 1986).

Two discrete groups of juvenile steelhead utilize different kinds of habitat provided by lagoons: steelhead juveniles using coastal lagoons for freshwater rearing throughout the year, and smolts from throughout the watershed using the lagoon primarily in the spring prior to seawater entry. Significant portions of steelhead populations rearing in upstream habitats migrate downstream to rear in coastal lagoons and estuaries (Bjornn 1971; Zedonis 1992; Shapovalov and Taft 1954). If rearing habitat is unavailable or of poor quality, these individuals' potential for survival is low (Hayes *et al.* 2006).

The Russian River, Tomales Bay, and San Francisco Bay are the three largest estuarine systems in the DPS. Smaller, but significant estuaries include: Salmon Creek, Estero Americano, Bolinas Lagoon, Pilarcitos, Tunitas, San Gregorio, Pescadero, Gazos, Waddell, Scott, Laguna, Wilder, San Lorenzo, and Soquel, Aptos estuaries. The Russian River estuary supports all populations from the Interior Diversity Stratum and three of 12 populations of the North Coastal Diversity Stratum. Tomales Bay supports Lagunitas and Walker Creek populations. San Francisco Bay supports all populations within both the Coastal and Interior SF Bay strata. The Santa Cruz Mountains Diversity stratum has more estuaries than any other stratum in the DPS.

[22] An ecotone is defined as a transitional habitat zone between different environments.

The Russian River receives artificially high summer flows and is maintained as an open-mouth estuary by frequent mechanical breaches. The repeated turnover from salt to fresh water reduces food productivity. The presence of saltwater also likely impedes the successful rearing of steelhead YOY and smaller parr. Though San Francisco Bay has likely always been a saltwater estuary, it has lost approximately 90 percent of the tidal marsh habitat associated with it (San Francisco Bay Area Wetlands Ecosystem Goals Project 1999). This has likely had a significant impact on its ability to support steelhead rearing and migration. Estuary conditions in the Santa Cruz Mountains Diversity Stratum are highly variable. Aptos and San Lorenzo estuaries are reduced in size from flood control developments and land use encroachments. Pescadero has an unexplained annual fish kill associated with its estuary. The Pilarcitos estuary typically dries up in response to over allocation of water in the basin, and Scott, Waddell, Gazos, and San Gregorio are functioning fairly well.

The generally inadequate condition of the estuarine PCE across the DPS has potentially important consequences for the conservation of CCC steelhead. Given their dependence on estuaries, and the high proportion of populations that depend on them, estuaries may function as keystone habitats. Their condition is likely to strongly influence the abundance and growth of all steehead populations upstream.

f. The DPS-- CCC Steelhead Critical Habitat

As described above, the current condition of PCEs of CCC steelhead critical habitat indicates that many PCEs are not currently functioning, and/or have had substantial degradation in their ability to establish the functions necessary to serve their intended role to conserve the species. Juvenile rearing habitat in streams and estuaries is particularly degraded, and this degradation is spread throughout the DPS. The current condition of PCEs for CCC steelhead is likely to maintain low population abundance across the DPS and result in continued loss of distribution and diversity in San Francisco Bay watersheds and the upper Russian River.

V. ENVIRONMENTAL BASELINE

The 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 projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR §402.02).

The *Environmental Baseline* describes the current condition of the habitat, including critical habitat, and the ESA-listed salmonid species within the action area. The *Environmental Baseline* provides the foundation upon which the effects analysis is built. By establishing the historical and current condition of the species and the habitat in the action area, we describe and analyze the conditions to which we will add the effects of the project under consultation. Our description (Section A.1 below) of the historical condition of the ecosystem (prior to European settlement and development) provides a context for subsequent trends, and for describing the current condition of critical habitat and the viable state of salmonid populations. Current conditions of habitat and salmonid populations within the action area (Section A.2. and B below) are followed by a description of the impacts of all the activities (such as the construction of dams, estuarine breaching, Russian River flow regulation, agriculture, fishing, ocean conditions, *etc*.) that have contributed to the current status of habitat and the species sub-populations (Section C below). Our ability to understand factors contributing to the baseline condition is also important for predicting future conditions and likely responses of salmonids to the effects of the proposed action, interrelated and interdependent actions, and cumulative effects.

A. Condition of Habitat/Critical Habitat within the Action Area

1. Historical Habitat Conditions within the Action Area

Conditions in the Russian River watershed prior to European settlement and development were often dramatically different from the conditions found today. Stream flow in the Russian River and it tributaries was characterized by episodic flows associated with climatic patterns. The Mediterranean climate of the Russian River watershed, was (and is) characterized by warm summers, mild winters, and winter-dominant precipitation regimes (SEC 1996). Most precipitation in the Russian River basin occurred between October and May, with resulting higher stream flows. During precipitation events, the steep slopes of the surrounding basin conveyed water into channels at discharges much higher than the mean annual flow. In the summer, stream flow in the Russian River's main stem was about 20 cubic feet per second (cfs) (SEC 1996); these low flow conditions likely persisted until the first winter rains.

The main stem of the Russian River was a dynamic meandering river which migrated across its floodplain creating ox-bows and side sloughs, and had a profusion of side channels, sand bars, islands and sloughs (Florsheim and Goodwin 1993). Rivers hydraulically segregate their sediments such that the coarser, larger gravels are stored in depositional sites in upland reaches, while smaller gravels are stored in the lower reaches (Mount 1995). This was probably the case for the Russian River and its tributaries in their unaltered state; most of the suitable spawning gravels were likely in upper reaches, with reduction of suitable spawning gravel in the middle

and lower reaches. Most of the 110 miles of main stem Russian River, and hundreds more miles in the tributaries, were likely historically available for salmonid spawning. The gravel available for spawning purposes was likely of suitable size and relatively free of fine silt. There was likely a high pool/riffle ratio which provided sufficient habitat for spawning purposes. An abundance of LWD was probably available in the form of root wads and fallen logs to create scour pools and provide cover and foraging sites for rearing salmonids. Low summer flows in the summer were likely, resulting in high water temperatures; however, the main stem probably contained numerous deep pools with lower cooler layers (Circuit Rider Productions 1994). Salmonids were able to survive in summer by seeking refuge in these stratified pools. The tributaries provided good quality habitat consisting of pools, instream cover, clean gravels, and sufficient canopy cover. In the tributaries there was likely more LWD instream as trees were recruited into the streams during storm events, bank erosion, land slides, and windthrow. This allowed for the creation of rearing pools and other elements of complex habitat. While there were likely ephemeral or intermittent streams in some areas of the Russian River watershed historically, Russian River tributary streams likely had more surface flow available throughout the year than currently available.

Zone 1A is roughly the same geographic area as the Mark West Creek watershed, which includes the Laguna de Santa Rosa. Information from this section comes primarily from two sources: Smith Consulting (1990) and the Laguna de Santa Rosa Foundation. The Mark West Creek watershed (≈160,000 acres) comprises approximately ten percent of the entire Russian River drainage. Several streams occur within this watershed, including the Laguna de Santa Rosa (the largest drainage), its main tributary Santa Rosa Creek, and several other smaller streams (*e.g.*, Copeland Creek). Historically, the Laguna de Santa Rosa consisted of oak woodland and savanna, riparian forests, streams, lakes, and perennial and seasonal freshwater wetlands. The qualitative factors affecting habitat discussed previously in this section in the paragraph related to the Russian River main stem (*e.g.*, LWD and gravel) are likely accurate for the Laguna de Santa Rosa watershed too. Salmonids likely used all of the perennial streams within the Laguna de Santa Rosa watershed for spawning and rearing. The Laguna de Santa Rosa acted as a natural reservoir during high stream flow events, and could store up to an estimated 80,000 Acre-feet of water. For the area of Guerneville, this could have resulted in a 14-foot reduction in the height of the 100-year flood.

NMFS has inferred historical estuarine habitat conditions by combining information on current conditions, limited historical and present day information about river flow and bar closures in the Russian River and other California estuaries, and information from the hydrologic study conducted by the Russian River Estuarine Task Force (RREITF) in 1993.

Given the information available[23], NMFS expects that prior to dams and diversions in the Russian River watershed, the estuary was likely open to ocean tides for several months between late fall and early spring in nearly all years, and then closed to ocean tides sometime during the late spring through the early fall of most years. This pattern of open estuarine conditions in the late fall, winter and early spring, followed by estuary closure to ocean tides in the spring,

[23] For example, RREITF compared the hydrologic conditions in the Russian River estuary with other estuaries in California. Their results indicate that tidal forces are not strong enough to maintain an opening in the barrier beach under all conditions (RREITF 1994).

summer, or early fall, remains evident today. For example, the bar at the mouth of the estuary closed in the spring (April-June) in 8 out of 12 years for the period 1996-2007 (Table 26 in *Effects Section*). This occurred even with inflows augmented by the dam releases.

Closure of the Russian River estuary's bar is a fairly complex process related to tides, waves and swells, sediment transport, and river flows (Largier 2008, RREITF 1994). For example, closure of the bar in 1992 occurred during both spring and neap tides, but favored neap tides (RREITF 1994). In general, the timing of the highest anticipated Russian River stream flows coincides with larger coastal waves at the mouth of the Russian River; with these conditions, the Russian River likely flowed to the ocean. As Russian River stream flow waned in the spring, sufficient hydraulic energy was not available to maintain a direct connection to the ocean. This, combined with the presence of bar building wave events[24], would often cause a barrier beach to form at the outlet of the estuary. In some instances, closure may not have occurred until late summer (Largier 2008) due to the absence of bar building wave events in the spring.

Historically, flows during the summers were low and were unlikely to have breached the barrier beach once it formed. Only limited flow data is available prior to the construction of the Potter Valley Project. At Geyserville, flows have been estimated at 20 cfs or less during most summers (SEC 1996). Flows were likely higher at the estuary, but not anywhere near the average 200 cfs summer season flow documented at the Guerneville gauge for the period 1940 - 1980 (RREITF 1994). Other information supporting the conclusion of a barrier beach at the Russian River's mouth in most summers includes reports in the late 1800s from early settlers, the Coastal Pilot, and the U.S. Coast and Geodetic Survey (RREITF 1994). In some wetter years, a perched lagoon[25] may have formed, with freshwater outflow over the estuaries' bar. The duration of the perched lagoon through the summer as river flows receded is unknown.

The migration timing of Russian River salmonids evolved to correspond with higher stream flows and open estuary connection to the ocean (Fukushima and Lesh 1998). Migration opportunities for adult Russian River salmonids usually began around October or November following sufficient rainfall. Chinook salmon would be the first salmonid to begin adult immigration, followed by coho salmon, then steelhead. Anticipated juvenile Russian River salmonid emigration corresponds with high winter and spring flows. In some years, depending upon weather and hydrology patterns, the estuary may have opened late or closed early, which may have prevented some portion of migrating adult salmonids from entering the Russian River to spawn, or preventing some juveniles to migrate to the ocean as smolts. Given the likely larger historical size of salmonid populations in the Russian River, these natural climate fluctuations are unlikely to have had any long-term impacts on salmonid population viability in the watershed.

[24] Under stormy seas conditions, sand is eroded from a barrier beach by long period swells that break high on the beach and then transport beach sand offshore. When the storm seas subside and shorter period waves and swells predominate, sand is transported back onshore, rebuilding barrier beaches (Dean 1974).

[25] NMFS defines a perched lagoon as having water surface elevation above mean high tide. Although this definition can include freshwater lagoons with closed sandbars, when we use the term perched lagoon in this biological opinion, we are referring to lagoons where freshwater flows out to the ocean over the sandbar at the lagoon's mouth.

Salmonid spawning in the lower Russian River estuary is highly unlikely to have occurred because water depth and flow levels during the spring would have made any spawning gravels unavailable for use. In the upper estuary it is possible that Chinook salmon and steelhead spawning may have occurred in some years if flow levels were low enough to provide spawning habitat. Coho salmon would have been unlikely spawners in the upper estuary based on their life history preference for spawning in smaller tributary streams.

NMFS expects that historically, the Russian River estuary either converted to freshwater after bar closure, or stratified, with denser salt water remaining at depth. The estuary's condition after bar closure was likely variable. Closed estuaries in California can become productive freshwater lagoons (Smith 1990), dependent upon the time of initial closure and freshwater inflow to the estuary. Conversion to freshwater occurs when freshwater from upstream builds up on top of the salt water layer, gradually forcing the salt water layer to seep back into the ocean through the barrier beach. In the estuary/lagoon systems Smith (1990) studied, it took at least one month for a freshwater lagoon to form. Freshwater conditions can also result from perched lagoons, a condition (as described above) where the estuary is closed to ocean tides but freshwater flows out over the bar. The freshwater outflow entrains some of the salt water at the boundary between fresh and salt layers, steadily removing salt water from the lagoon[26]. NMFS staff have observed such a conversion in the Carmel Lagoon from 2005-2007 (John McKeon, NMFS, personal communication, 2008). Closed estuaries may also remain stratified, with heavier salt water on the bottom.

Information does not exist on water quality conditions in the Russian River estuary prior to increased summer flows in the Russian River from the Potter Valley Project. Currently, the Russian River estuary is known to stratify after formation of the barrier beach in the summer. Creation of a freshwater lagoon has not been observed. However, the Russian River estuary has not been studied for long time periods after bar closure. The available data on the water quality condition of the closed Russian River estuary are limited to three weeks or less duration after bar closure. (M. Fawcett, Merritt Smith Consulting, personal communication, 2005).

If the estuary converted to freshwater historically, habitat was likely high quality for salmonids rearing during the summer months. Smith (1990), Zedonis (1992), Larson (1987), and Bond (2006) evaluated closed freshwater lagoons in California and found good salmonid rearing habitat in those lagoons, including abundant food supplies and increased salmonid growth rates over stream-raised fish. If the Russian River remained stratified during the summer, rearing salmonid productivity was also likely relatively high. The Navarro River estuary, which is more similar in size and configuration to the Russian River estuary than the smaller estuary/lagoons studied by Smith and Bond, did not convert to freshwater after it closed and became a lagoon in September of two consecutive years (1996 and 1997). Nevertheless, steelhead productivity appears higher than productivity in other open, salt water estuaries in California as shown in Table 12, although not as high as productivity in closed freshwater lagoons. Steelhead productivity in the Navarro was high due to abundant food and a stable surface freshwater layer (Cannata 1998).

[26] Several studies have demonstrated salt water flushing related to freshwater flows over salt water layers. See, for example, Debler and Imberger (1996), Western et al. (1998), Coates et al. (2001), and Coates and Guo (2003).

Table 12. Summary of juvenile steelhead data from California estuaries (modified from Bradford 2008). Estuarine type and steelhead densities characterize conditions in summer through fall. Area is from cited reports or rough approximations by comparison with other estuaries of known size.

River	Estuary Type (summer -fall)	Area (1000m^2)	Steelhead (1,000s)	Steelhead Density (#/m^2)	Reference
Scott	Freshwater	8	2	0.25	Bond 2006
Mattole	Freshwater	180	25-30	0.15	Zedonis 1992
Pescadero	Freshwater/ Stratified	30	9.9	0.30	Smith 1990
San Gregario	Freshwater	43	11	0.25	Smith 1990
Waddell	Freshwater	18	9-15	0.67	Smith 1990
Navarro	Stratified	377	9	0.024	Cannata 1998
Russian	managed as open and largely saline	585	Few	Very low	SCWA 2006
Garcia	Open/largely saline	200	Few	Very low	Higgins 1995
Albion	Open/largely saline	160	Few	Very low	Maahs and Cannata 1998
Smith	Open/largely saline	1171	5.4-13.4	0.005-0.01	Quinones and Mulligan 2005

[1] While the condition (open, freshwater, *etc.*) of these waterbodies appear to correlate well with steelhead productivity, other factors not represented on this table (e.g., steelhead prey abundance) likely play a major role in steelhead productivity in estuaries and may not be directly correlated with estuary type as described in this table.

Uncertainty remains regarding the historical frequency of: bar closure, conversion to freshwater or stratification, and steelhead productivity in the Russian River estuary during the summer and fall. Nevertheless, we believe our conclusion, that the estuary closed in most years and steelhead productivity during the summer and fall was higher than when the estuary remained open to the ocean, is reasonable.

2. Current Condition of Habitat/Critical Habitat within the Action Area

The condition of CC Chinook, CCC coho salmon, and CCC steelhead habitat and critical habitat within the Russian River basin has been degraded from conditions known to support viable salmonid populations (64 FR 24049, 70 FR 52488). Habitat, including critical habitat, in the streams within the action area currently consists of limited quantity and quality summer and winter rearing habitat, as well as marginal spawning habitat for all three species. Compared to historical conditions, there are fewer pools, limited cover, and reduced habitat complexity. The limited instream cover that does exist is provided mainly by large cobble and overhanging vegetation. Instream large woody debris, needed for foraging sites, cover, and velocity refuges is especially lacking in most of the streams throughout the basin. NMFS has determined that these degraded habitat conditions are, in part, the result of many human-induced factors affecting critical habitat including: dam construction, agricultural and mining activities, urbanization, stream channelization, water diversion and logging among others. These factors will be discussed in more depth in subsequent sections of the *Environmental Baseline*.

Not all streams in the Russian River watershed were designated as critical habitat for CC Chinook salmon, CCC coho salmon, and CCC steelhead. For example, only the mainstems of the Russian River (including its estuary) and some of its largest tributaries (such as Dry Creek below WSD) were designated as critical habitat for CC Chinook salmon. Steelhead critical habitat includes these areas and numerous smaller tributaries in the Russian River watershed. Not all the smaller tributaries are designated. For example, the Santa Rosa Creek watershed was not designated as CCC steelhead critical habitat. Complete descriptions of the locations of Chinook salmon and steelhead critical habitat in the Russian River watershed can be found in 70 FR 52488.

Designated critical habitat for CCC coho salmon includes all river reaches accessible to coho salmon within the range of the ESU. NMFS defines accessible as all reaches below longstanding natural barriers and several dams, including CVD and WSD (64 FR 24049). Therefore, all of the stream reaches accessible to coho salmon in the action area are part of critical habitat for CCC coho salmon, including stream reaches upstream of culverts which currently block coho salmon access.

The number of stream miles of existing spawning, rearing, and migration habitat (PCEs) for CC Chinook salmon critical habitat included in the action area are provided in Table 13. The current condition of critical habitat for CCC steelhead in the action area is shown in Table 14. The ratings for current habitat conditions completed by NMFS' Critical Habitat Analytical Review Team (CHART) were conducted on a broad basis and may not accurately reflect site specific conditions. The CHARTs did not assess the current condition of coho salmon critical habitat. A more detailed assessment of habitat conditions, including coho salmon habitat, is provided following Tables 13 and 14.

Table 13. The number of stream miles containing each PCE for CC Chinook salmon within the action area, with current habitat condition rated as good, fair, poor, and unknown by the CHART (NMFS 2005b).

Area	PCE	Good	Fair	Poor	Unknown	Total
Russian River	Spawning	35.4	18.0	21.6	0.0	75.0
	Rearing	0.0	0.0	58.3	43.9	102.2
	Migration	35.4	58.3	0.0	8.5	102.2
Dry Creek	Spawning	14.3	0.0	0.0	0.0	14.3
	Rearing	0.0	14.3	0.0	0.0	14.3
	Migration	14.3	0.0	0.0	0.0	14.3
Mark West Creek	Spawning	0.0	0.0	3.5	0.0	3.5
	Rearing	0.0	3.5	0.0	0.0	3.5
	Migration	0.0	3.5	0.0	0.0	3.5
All Action Area	Spawning	49.7	18.0	25.1	0.0	92.8
	Rearing	0.0	17.8	58.3	43.9	120.0
	Migration	49.7	61.8	0.0	8.5	120.0

Table 14. The number of stream miles containing each PCE for CCC steelhead within the action area, with current habitat condition rated as good, fair, poor, and unknown by the CHART (NMFS 2005b).

Area	PCE	Good	Fair	Poor	Unknown	Total
Russian River	Spawning	0.0	39.7	23.3	11.0	74.0
	Rearing	0.0	40.3	59.4	0.0	99.7
	Migration	60.2	39.5	0.0	0.0	99.7
Dry Creek	Spawning	14.4	0.0	0.0	0.0	14.4
	Rearing	0.0	14.4	0.0	0.0	14.4
	Migration	14.4	0.0	0.0	0.0	14.4
Mark West Creek (excluding Laguna de Santa Rosa)	Spawning	4.4	17.6	5.2	1.1	28.3
	Rearing	14.1	14.2	3.6	0.0	31.9
	Migration	31.9	0.0	0.0	0.0	31.9
Laguna de Santa Rosa	Spawning	0.0	0.0	0.0	0.0	0.0
	Rearing	0.0	0.0	0.0	0.0	0.0
	Migration	0.0	1.5	0.0	0.0	1.5
All Action Area	Spawning	18.8	57.3	28.5	12.1	116.7
	Rearing	14.1	68.9	63.0	0.0	146.0
	Migration	106.5	41.0	0.0	0.0	146.0

a. *Current Condition of Habitat in the Russian River Main Stem*

Overall, migration habitat in the main stem appears to be in moderate condition for all three species. Winter flows generally provide unimpeded passage conditions for adult salmonids that utilize the main stem and tributaries for spawning. During dry water years stream flow in reaches downstream of Cloverdale may be insufficient for adult salmonid passage between storm events. Seasonal dams and seasonal road crossings may cause minor delays for early adult Chinook salmon migrating in the main stem. Given their later spawning migration times, coho salmon and steelhead are not impacted by these impediments. The seasonal dams and road crossings are typically out of the main stem by the time adult coho salmon and steelhead immigrate, and fish ladders are present on the Mirabel and Healdsburg dams. Runs of coho salmon and steelhead generally commence only after early season rain events. Passage conditions in most years are suitable for salmonid smolts emigrating from the Russian River (SCWA 2005); however, smolt emigration during dry water years may have been reduced, exposing them to stressful water temperatures and increased predation (Corps and SCWA 2002). Smolt migration may be slowed by the Mirabel Rubber Dam (Manning *et al*. 2006).

Overall salmonid spawning habitat in the main stem has been negatively affected by geomorphic changes to the stream channel caused by dam construction and concomitant changes in sediment delivery and stream flow patterns, gravel extraction, channelization, and agricultural impacts. Nevertheless, the majority of the remaining good Chinook salmon spawning habitat is located in the river's main stem. About half of the spawning habitat for Chinook salmon in the Russian River is rated as good, with the rest being rated either fair or poor by the CHARTs (NMFS 2005*b*). Elevated fall flows associated with water management provide good spawning habitat for adult Chinook prior to the onset of winter rain events. Most information suggests that coho salmon do not utilize the main stem Russian River for spawning. About half the spawning habitat for steelhead in the Russian River is rated as fair, with the rest being rated either poor or unknown (NMFS 2005*b*). Steelhead use Russian River tributary streams for spawning more often than Chinook salmon.

Salmonid rearing conditions in the Russian River main stem vary considerably from the lower river near Monte Rio to the upper river in Ukiah. Rearing conditions for steelhead are marginally suitable in the segment from Cloverdale upstream to Ukiah, with the best habitat in the "Canyon" reach just north of Cloverdale. Streamflow conditions are largely controlled by sustained releases from CVD of more than 250 cfs for many weeks or months during the summer. The interagency flow-habitat assessment study, described in the *Effects of the Action* section, found a clear negative relationship between flow levels and availability of rearing habitat for steelhead in the upper Russian River.

The alluvial valley reaches between Ukiah and Hopland and Cloverdale and Healdsburg have been affected more by channelization, aquatic habitat simplification, loss of riparian vegetation, bank stabilization, gravel extraction, and agricultural practices as compared to more confined reaches such as the Canyon reach between Hopland and Coverdale. Summer rearing habitat in the main stem from Cloverdale downstream to Monte Rio is poor due to summer water temperatures that typically exceed thermal tolerances of rearing salmonids (Corps and SCWA

2004). This segment provides both minimal amounts and marginal quality rearing habitats for these species. Therefore, our overview of summer rearing conditions in the Russian River main stem will focus primarily on juvenile steelhead rearing habitat from Ukiah downstream to Cloverdale, a 34 mile stream segment.

The 20 mile reach of the upper Russian River from Ukiah downstream to Hopland is characterized by its low gradient, which influences the quality of habitats used by steelhead. SCWA surveyed segments of this reach in 2002, and found 94% flatwater habitat, 1% deep pool, less than 1% cascade, and 5% riffle habitat (SCWA 2003). Habitat utilization by juvenile steelhead during the summer was found to be almost exclusively in cascade and riffle habitat types (SCWA 2003). Halligan (2004) reports that this reach is dominated by gravel substrates, with 80% of the embeddedness values rated as good (*i.e.*, pool tailouts <25% embedded), or fair (25-50% embedded). Halligan (2004) considered rearing habitat for steelhead to be poor because shelter ratings are low in riffles, pools and flat habitats. As a result of flood conditions that occurred in late 2006, current shelter ratings may have improved slightly over those reported by Halligan. NMFS staff conducting monitoring work in the upper main stem has observed recruitment of groups of alder trees (*Alnus* spp.) that form complex habitat and velocity refuges that have likely improved shelter ratings within this reach.

Shade canopy in the reach is relatively low at 18%, which is partially influenced by the wide wetted channel. Riparian areas throughout the reach consist of willows (S*alix* spp.), and alder near the waters edge and Fremont cottonwood (*Populus fremontii*), and black walnut (*Juglans californica*) at the top-of-bank. Agricultural or urban activities usually limit the riparian zone to the top-of-bank where vineyards or other activities encroach up to the rivers banks. The non-native invasive giant reed (*Arundo donax*) occurs throughout the upper Russian River reach from Ukiah to Hopland. Circuit Rider Productions (2001) reports that this reach has a total of 16.39 acres of giant reed that has been identified and mapped in order to prioritize eradication and restoration of existing sites. Giant reed has been found to have negative effects on diversity and abundance of terrestrial insects in the riparian zone that are important as food sources for rearing salmonids (Circuit Riders Productions (2001).

The Canyon Reach extends from Hopland downstream 14 miles to Cloverdale. The upper four mile section from Hopland downstream to Squaw Rock is similar to the upper Russian River reach with dominant flatwater habitats and a well developed riparian zone; whereas the 10 mile segment from Squaw Rock to Cloverdale is characterized by steep canyon topography, fast water habitats, and substrates consisting of large boulders and bedrock. Surveys conducted by SCWA (2003) found that riffle habitat comprised 34% of the segment, the greatest concentration of this preferred rearing habitat for steelhead in the Russian River. Cascade habitat, also preferred by juvenile steelhead, makes up 2% of the habitat in the canyon reach below Squaw Rock. Stream gradient and channel confinement below Squaw Rock results in fast water habitat that is preferred by juvenile steelhead. This reach also has suitable stream temperatures that are conducive to juvenile steelhead rearing during the summer. As mentioned above, physical habitat and marginal stream temperatures limit juvenile steelhead use between Cloverdale downstream to Monte Rio.

SCWA (2003) reports that riparian characteristics below Squaw Rock are patchy in nature, likely due to the high flows that create increased shear stress within the stream channel during the winter. Riparian habitat in this reach is less affected by anthropogenic factors, yet there appear to be remnant effects from the railroad grade that flanks the canyons' west side, and some riparian impacts from work conducted along U.S. Highway 101 on the east side of the canyon.

b. Current Condition of Habitat in Dry Creek

Dry Creek and its tributaries are generally accessible to salmonids. WSD is a complete barrier to migration and some small seasonal dams on tributaries may block migration. Flow in Dry Creek, augmented by WSD releases, is usually sufficiently deep to allow fish to easily pass most shallow areas. Water temperatures are generally sufficiently cool and suitable for salmonids; however, sometimes adult Chinook salmon immigrate as early as September. Because of a loss of riparian vegetation resulting in increased solar inputs to the stream, water temperature in the lower portion of Dry Creek in the late summer is not optimal for adult Chinook salmon. However, the majority of adult Chinook salmon migrate in October and November, a time with generally adequate water temperatures for adult Chinook salmon. Coho salmon and steelhead migrate later in the fall and winter; water temperatures in Dry Creek are adequate for immigration of adult coho salmon and steelhead. Instream habitat structure is limited in Dry Creek, which may limit cover for migrating adults to escape predators. Also, the limited instream habitat structure results in limited pools for adults to escape from high flows. Habitat conditions are sufficient for smolt emigration for all three species.

Dry Creek provides adequate depth and flow for salmonid spawning, but resting areas for adult fish are limited due to the absence of deep pools. This is exacerbated by a lack of LWD and boulders, which would increase habitat complexity. Pool/riffle habitat, which serves as prime spawning habitat for steelhead and salmon, is also limited. As described below in **B. Status of Listed Species within the Action Area,** lack of cover and complexity has not precluded relatively large numbers of Chinook salmon from spawning in Dry Creek.

The lack of LWD and boulders also increases potential for scour of stream bedload. This lack of instream habitat structure combined with reduced riparian habitat leads to increased stream bank erosion when subjected to high flows. Stream bank erosion on Dry Creek has caused increased delivery of fine sediment, negatively affecting the quality of spawning habitat. WSD blocks sediment from recruiting to lower Dry Creek; this has resulted in numerous sites of exposed bedrock along the creek (S. White, SCWA, personal communication, January 3, 2007). The availability of spawning habitat in Dry Creek is less for coho than for steelhead or Chinook salmon because coho salmon use smaller gravels for spawning than steelhead or Chinook salmon (Corps and SCWA 2004). These smaller gravels may be getting transported out of the upper reach of Dry Creek more readily due to the high flows in this creek (Corps and SCWA 2004). Coho salmon redds, which are constructed from November through January, are more subject to scour because they are subjected to a higher frequency of winter flow events. Higher flows, occurring in the latter part (January) of the spawning and incubation season, have the greatest potential to scour the most redds and incubating alevins (Corps and SCWA 2004). In an evaluation of potential scouring of salmonids redds conducted by the SCWA, coho salmon redds had the highest frequency of scour potential in Dry Creek. Water temperatures are good in Dry

Creek for incubation. However, in the lower portion of Dry Creek during the latter part of the spawning season (April and May) water temperatures are too warm for incubation, often exceeding 15° C. As previously mentioned in Tables 13 and 14, CHART has rated spawning habitat as good in Dry Creek for Chinook and steelhead. There is no rating of coho spawning habitat by CHART in Dry Creek; however, based on the conditions described above, we conclude that spawning habitat for coho salmon is in fair to good condition in Dry Creek.

Salmonid rearing habitat in Dry Creek is marginal. Chinook salmon have a limited rearing period in the action area – typically about two to four months (February through May) before emigrating to the ocean. Both coho salmon and steelhead have extended freshwater rearing life histories and would be expected to rear for one or more years before emigrating; therefore, juveniles of these species would need summer and winter rearing habitat. While temperatures in Dry Creek are generally favorable for salmonid rearing, other rearing habitat attributes are lacking or in poor condition. Riparian vegetation provides shade and a source for allochthonous inputs (food and woody debris) along much of the stream and its tributaries. However, the riparian vegetation has been encroached upon and the width of the riparian areas has diminished as vegetation was removed primarily to benefit agriculture. The reduction of riparian vegetation is particularly noticeable on the lower portions of tributaries and the lower two miles of Dry Creek.

Dry Creek is also lacking in riffles, cover, and instream structure that severely limits salmonid production (SEC 1996). The lack of these habitat elements result in limited areas where juveniles can find refuge from high water velocities and cover for escaping predators. This lack of cover also limits sites where there is deposition of loose gravels and cobbles which provide habitat for aquatic invertebrates – the preferred prey of juvenile salmonids (Corps and SCWA 2004). Also, flow management, bank stabilization, and blockage of sediment transport by WSD have lead to channel incision, channel straightening, and bank instability. These factors work in concert to leave the creek lacking in complex habitat such as back water eddies and pools, and the creek is disconnected from its flood plain. The low incidence of pools in the creek limits rearing habitat for coho salmon in particular, since they prefer pool habitat over riffle habitat.

The CHART concluded that rearing habitat for Chinook salmon and steelhead in Dry Creek was fair (Tables 13, 14); however, biologists from NMFS, the Corps, SCWA, CDFG, and Entrix conducted an analysis of aquatic habitat conditions in Dry Creek and determined that habitat conditions for steelhead rearing are poor in Dry Creek (see Appendix F of Corps and SCWA (2004)). The poor rearing conditions in Dry Creek are attributable to current operations at WSD. The SCWA's flow management continues to greatly influence the quality and quantity of PCEs of critical habitat for salmonids in the 14 mile segment of Dry Creek below WSD. During the past 15 years, SCWA has generally sustained releases from WSD of more than 110 cfs for many weeks or months during the summer. The interagency flow-habitat assessment study, which is also described in the *Effects of the Action* (Section VI.F), found a clear negative relationship between flow and availability of rearing habitat for juvenile salmonids. SCWA's operations that maintain elevated flows in Dry Creek result in very limited amounts of suitable and optimal quality habitats for salmonid rearing. These current velocities resulting from the flow releases exceed the tolerance of juvenile salmonids, thereby reducing habitat suitability. Poor winter rearing habitat conditions are exacerbated by the Corps' flood flow releases, which further limit

foraging opportunities for juvenile coho salmon and steelhead by increasing the duration of flows at which these juveniles must seek velocity cover.

c. Current Condition of Habitat in Zone 1A

This section describes the current condition of the PCEs of the salmonid habitat in the Zone 1A tributaries, including critical habitat for coho salmon. This section is divided into two parts, based on how SCWA manages these streams: constructed flood control channels and natural waterways. Most of the creeks in this zone are managed as both constructed flood control channels and natural waterways. The upper portions of the creeks are usually managed as natural waterways and the lower portions, found in the more urban areas, are typically constructed flood control channels. The first part of this section covers constructed flood control channels found in Santa Rosa Creek and the Rohnert Park-Cotati area. The second covers natural waterways which include the upper portions of the Santa Rosa Creek and Rohnert Park-Cotati area.

Zone 1A- constructed flood control channels. Instream salmonid habitat conditions within the constructed flood control channels are generally poor. These channels have been straightened and roughness elements (*e.g.*, LWD and boulders) have been removed to reduce turbulence and retention time of flows. Some channels are further modified by lining them with concrete or riprap and converting the channel shape to a trapezoid. Also, much of the woody vegetation has been removed from the stream banks, and the streams have been disconnected from their floodplains.

Migration habitat for juvenile and adult salmon and steelhead in the constructed flood control channels is degraded relative to historic conditions. Habitat complexity including reduced instream and riparian cover is especially lacking. Channel morphology has been simplified as well. Small lateral bars and in-channel vegetation, needed to create sinuosity of the channel and adequate depth for migration, are no longer evident in most of the flood control channels. This channel condition allows the stream flow to spread over the bottom width, reducing depth, and creating a laminar flow. This reduction of depth creates fish passage barriers for upstream migration when surface flow is relatively low. Many of the flood control channels have depths of only 2 to 3 inches. Adult salmon and steelhead generally require a minimum depth of 18 centimeters (7 inches) for upstream migration (Thompson 1972). As a result, adult migration opportunities are reduced from historic conditions and limited to periods when surface flow is higher and depth is adequate for passage. Also, during high water events, some adult or juvenile salmonids might become entrained in the unscreened diversion to Spring Lake, a SCWA flood control reservoir. Also, the SCWA has three inchannel flood control dams and reservoirs on Santa Rosa Creek tributaries; these facilities are complete barriers to migration. Migration opportunities for smolting salmonids in the flood control channels is fair, but opportunities for non-smolting juvenile salmonids is poor, primarily because of reduced summer and fall flows from water extraction, and reduced habitat complexity from flood control activities.

Most of the flood control channels have conditions unsuitable for spawning for salmon and steelhead; however, a small amount of suitable spawning habitat exists in a few flood control channels. The low-gradient straightened channels are subject to sediment deposition (Corps and

SCWA 2004). Flow through the low gradient (between 0.05 percent and 0.4 percent) areas of these channels does not have the energy necessary to mobilize the excess sedimentation found in these streams. Also, the lack of channel roughening elements such as LWD and instream vegetation reduces the amount of habitat complexity, and the ability of the stream to sort and retain appropriate gravels for spawning areas. The quality of spawning gravel is limited by high rates of gravel embeddedness or high levels of fine sediments. Urbanization and agriculture have added to the high sediment levels. The reduced amount of LWD, instream and riparian vegetation, and boulders leads to reduced amount of cover used by adult salmonids (Bisson *et al*. 1987; Bjornn and Reiser 1991).

Rearing conditions for salmonids are in poor condition in the flood control channels. The significant lack of channel roughening elements in the constructed flood control channels reduces cover and resting locations. This deficit in channel roughening elements has resulted in reduced pool habitats. According to Bisson and Bilby (1987), one of the most important functions of LWD in forming salmon habitat is the creation of rearing pools. Pool/riffle type habitat, necessary for successful salmonid rearing, is poorly developed due to the straightened channel, removal of riparian vegetation, bank stabilization activities, and sedimentation from urban and agricultural land uses. The lack of sinuosity in these channels inhibits the formation of pools. The limited amount of pools that do exist are relatively shallow. Pools, and especially deep pools, are important to salmonids for a variety of reasons, particularly for coho salmon[27]. Pools function as refugia for fish during floods and droughts (Sedell *et al*. 1990). The greater depth found in pools, compared to riffles, affords fish a better opportunity to escape from predators. Pools allow coexisting fish species and/or age classes to "stack" or occur in layers within the water column (Bisson *et al*. 1988). This divides territorial units which reduces density related competition. These limited resources are particularly troublesome for coho salmon, as they prefer pool habitat over riffles for rearing.

There is limited riparian vegetation near the channels, as most has been removed during flood control activities, though some urban and agricultural land uses have also reduced riparian vegetation. One contribution of riparian vegetation is to hold stream bank soils in place. Therefore, erosion of banks is more common in areas of reduced riparian vegetation. The bank erosion contributes fine sediments to the channels and fills in pools. The reduced riparian canopy results in higher stream temperatures. As described in the *Status of the Species* Section, higher water temperatures can negatively influence salmonid egg development, juvenile appetite and growth and can cause death when the temperatures are high enough. Because the channels are disconnected from their flood plains and much of the large woody riparian vegetation has been removed, complex instream habitat such as backwaters, eddies, and side channels are very minimal in the channels. These areas serve as summer and winter rearing areas for juvenile fish and provide critical refuge during floods (Moore and Gregory 1988*a*; Moore and Gregory 1988*b*; and Sedell *et al*. 1990, Moyle 2002, Quinn 2005).

Water quality is poor in many of the flood control channels. Urban runoff, including stormwater discharge, and agricultural runoff introduces toxins, nutrients, and fine sediment to these

[27] The historical presence of coho salmon on the Santa Rosa plain is unknown, but probable given their preference for rearing in off-channel habitat, which probably existed prior to creek channelization. Pools can also be particularly important for steelhead in California, serving as temperature refuges during the summer (Nielson 1994)

channels. These effects are most pronounced following early season or large rain storms. Other sources of toxins in the channels are herbicides applied directly to waterways to control invasive species of plants, such as water primrose (*Ludwigia* spp.) and cattail (*Typha* spp.); these chemicals are applied primarily in the spring and summer. Many of the flood control channels are dry in the summer or have shallow stagnant water. This is partially due to the low gradients that exist in these channels, increased sediment delivery to the channels, and water extractions. The poor summer flows, the loss of riparian vegetation, and the limited amount and depth of pool habitat increases summer water temperatures in these flood control channels. Levels of DO are reduced in the flood control channels, further reducing water quality.

Zone 1A natural waterways. In contrast to constructed flood control channels, natural waterways do not have the artificial trapezoid channel shape or the amount of bank stabilization structures. Sediment removal is not routinely performed in natural waterways, but occasionally sediment and debris removal is conducted in response to large storm events on an as needed basis (Corps and SCWA 2004). Many of the natural waterways were cleared of vegetation in the 1970s and 1980s, but this practice ended in 1987 (Corps and SCWA 2004).

The natural waterway portion of Santa Rosa Creek appears to be in fair condition for migration. Migration habitat in the natural waterway portions of the Rohnert Park-Cotati area is in poor to fair condition. There is usually sufficient flow during the steelhead migration period, however, there is not much instream cover or pools to provide refuge from high water velocity or cover from predators. Also, tributaries to Santa Rosa Creek have some permanent dams or grade control structures which diminish migration opportunities. The natural waterway portions of the Rohnert Park-Cotati area are in poor to fair condition, primarily because of loss of instream habitat. Tributaries throughout Zone 1A contain culverts and other impediments to passage of adult and juvenile salmonids – some of these objects are total barriers and others are partial barriers. Migration habitat for smolting salmonids is generally satisfactory, but opportunities for non-smolting juvenile salmonids is fair to poor, primarily because of reduced summer and fall flows from water extraction, and reduced habitat complexity from flood control activities.

Spawning habitat in the natural waterway portion of Santa Rosa Creek is in fair condition for salmonids. Sufficient spawning gravels are available; however, they are more embedded than in the middle section of the creek due to erosion from roads (CDFG 2006). Spawning habitat in the natural waterway portion of Santa Rosa Creek is also diminished due to nutrient loading in the stream from livestock and failing septic systems. Spawning habitat in the natural waterway portions of the Rohnert Park-Cotati area is in poor condition. These are low gradient streams with limited pool/riffle habitat and limited cover. Copeland Creek is an exception to this and has some potential habitat for steelhead (S. Chase, SCWA, personal communication, January 16, 2007). The upper portion of this creek runs through Fairfield/Osborne Preserve and is well shaded and in a fairly natural state. Two steelhead were found in this creek in the summer of 2006.

Rearing conditions in natural waterway portions of Santa Rosa Creek are in fairly good condition. There is adequate canopy cover in the form of mature, native riparian vegetation. The headwaters of Santa Rosa Creek are situated in Hood Mountain Regional Park where the stream is protected from most anthropogenic disturbances, though some recreation occurs in and

near the stream. All but two tributaries to Santa Rosa Creek (Fountain Grove Creek and Hood Mountain Creek) are managed, at least in part, as constructed flood control channels. Therefore, most of the rearing habitat in the tributaries to Santa Rosa Creek is degraded. Rearing habitat in the natural waterway sections of the Rohnert Park-Cotati area is in poor condition. Most of the natural waterway portions of the creeks dry in the summer or have warm water temperatures due to removal of riparian vegetation, limited canopy cover, and water extraction. Agricultural runoff also results in water quality impairments. Copeland Creek retains some fair rearing habitat in the summer. Between 1999 and 2003, SCWA restored portions of this stream by adding riparian vegetation to provide more canopy cover, and as a source of food and other allochthonous inputs.

d. Current Condition of Habitat in the Estuary

The Russian River estuary is a drowned river valley formed via erosion when sea level was lower during the early Pleistocene (Erskian and Lipps 1977). The bed of the estuary rises above mean sea level near Duncan's Mills, about five miles from the River's mouth. Ocean tides can influence water surface elevation in the river as far as 10 miles upstream near Monte Rio (Corps and SCWA 2004), and directly affect water elevation about five to seven miles upstream in the vicinity of Austin Creek (Erskian and Lipps 1977, Corps and SCWA 2004). Tides range approximately 6 feet and are diurnal (Erskian and Lipps 1977). Sediments are fluvial (gravels and cobbles), marine sands (Erskian and Lipps 1977), and fine silts and mud in some areas of the estuary (NMFS staff observations 2007). Several Russian River tributaries drain directly to the estuary, including Willow Creek, Freezeout Creek, Dutch Bill Creek, Austin Creek, and Sheephouse Creek (Figure 6).

Artificial breaching has created a mostly marine environment in the estuary in the summers. Forty three fish species have been identified in the estuary (including salmonids) during monitoring in the late 1990s and early 2000s (Corps and SCWA 2004). Most common were marine or estuarine species such as topsmelt (*Atherinops affinis*), starry flounder (Platichthys stellatus) and Pacific herring (Clupea pallasii) (SCWA 2004b). Macroinvertebrates such as opossum shrimp (*Neomysis mercedis*) , bay shrimp (*Crangon sp*.), Dungeness crab (*Cancer magister*), and amphipods (*Eogammarus confervicolus*) are also present (Corps and SCWA 2004). Pinnipeds found in the estuary and on its bar include harbor seals (*Phoca vitulina*), which are found year round; and sea lions (*Zalophus californianus*) and elephant seals (*Mirounga angustirostris*) are found less regularly (Corps and SCWA 2004).

Artificial breaching and high summer flows have had large impacts on salmonid habitat conditions. The following is a summary of these impacts, which are described in detail in the ***Effects of the Action*** (Section VI. G).

Salmonid migration habitat in the estuary is in relatively good condition. The estuary is usually open due to winter storms during the steelhead and coho migration period. During the spring months the estuary is usually open, which allows for salmonid smolt outmigration. In the fall, the estuary is often open[28], but it does close periodically. When it closes, it may breach naturally

[28] The estuary remains open during the summer and early fall due to a combination of artificial and natural breaching.

or require mechanical breaching to open. Breaching in the fall may provide attraction flows which could encourage more Chinook salmon to migrate upstream prior to fall and winter rains[29], which may expose some adults to impacts from recreational fishing and above optimal water temperatures. No physical impediments to migration such as dams, grade control structures, or culverts exist within the estuary. Summer water temperatures are generally adequate, as the result of the coastal climate.

The spawning PCE of critical habitat is not applicable to the estuary, as no Chinook salmon, coho salmon, or steelhead spawn within the estuary. Given the life history strategies of these three species, it is unlikely that any spawning occurred in the estuary historically.

The estuary provides suitable conditions for short-term rearing and transition to the marine environment for salmonid smolts. Early breaching events have not reduced habitat availability for smolts that arrive at the estuary during the late winter and spring months. The limited number of artificial breaches during the winter and early spring likely mimics natural estuary function when smolts utilize the estuary. Emigrating salmon smolts move through the estuary and into the marine environment when the estuary is in the open condition. If not, then emigrating smolts utilize the available estuarine habitat until the barrier beach is breached (naturally or artificially) when they are then able to migrate to the ocean. The current breaching regime may benefit smolting salmonids by allowing more frequent access to the marine environment in some years.

The juvenile steelhead rearing PCE of critical habitat is degraded in the estuary during the late spring, summer, and early fall by repeated mechanical breaching for flood control. Many estuaries in California convert to a productive freshwater lagoon following formation of a barrier beach. Following formation of a barrier beach the estuary slowly converts to freshwater; the process may take 1 month or more (Smith 1990). Until the conversion process has completed, stratification of the water by salinity occurs. Saltwater, being denser, is located at the bottom, while freshwater is found on top. Stratification can limit both the quantity and quality of freshwater steelhead habitat, relative to a freshwater lagoon. During the onset of stratified conditions, some habitat is present for YOY and 1+ juvenile steelhead in the shallow freshwater lens atop the estuary. These life stages are restricted by the highly saline and low DO conditions at the bottom of the estuary. Aquatic invertebrates, the prey base for juvenile steelhead, are often more diverse and abundant in a lagoon. When conversion of an estuary to a lagoon is complete, steelhead can have more abundant space and prey for survival.

[29] When the estuary closes, water surface elevation often rises prior to SCWA breaching. As the estuary drains, the outflow may encourage Chinook salmon to enter. NMFS compared the dates of estuary closure and breaching in the fall with Chinook salmon counts at Mirabel Dam. In some cases the salmon counts appear to rise shortly after the estuary is breached. However, NMFS found at least one year (2002) when over 1,000 Chinook salmon were counted at Mirabel (26-Sep.) prior to closure of the bar (30-Sep.) and the onset of fall breaching. Thus, breaching does not trigger large numbers of Chinook salmon to enter the estuary in all cases. Increase in numbers of Chinook salmon are also more generally correlated with increased flows in the Russian River which often start in late October or early to mid November.

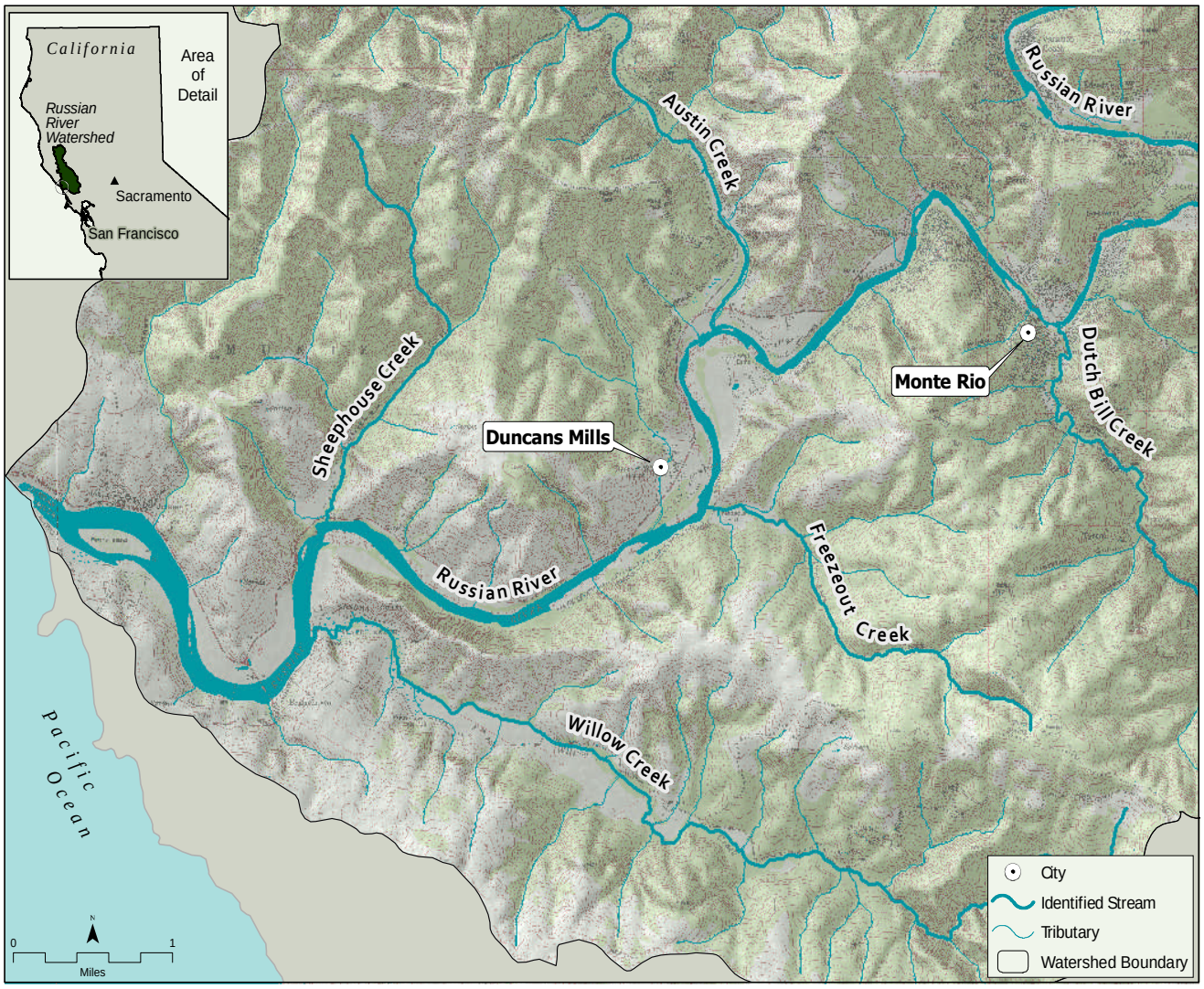

Figure 6. Russian River Estuary.

Although there is uncertainty regarding whether or not the estuary historically converted to a completely freshwater lagoon or remained stratified after bar closure, NMFS expects that given the high freshwater flows sent from WSD and/or CVD down the Russian River and into the estuary, conversion to a mostly freshwater lagoon, or stratification with a deep freshwater surface layer, is now likely if breaching did not occur. High river flows would eventually overtop the bar and entrain most of the salt water as they flowed out over the bar and over an ever shrinking salt water lens (a perched lagoon)[30]. Or, if flows were somewhat lower, equilibrium between inflow and outflow through the bar would establish and the freshwater would likely push most of the salt water through the bar and into the ocean.

The frequent artificial breaching of the barrier beach disrupts the conversion processes described above. Every time the barrier beach is mechanically breached, much of the limited existing freshwater lens (rearing habitat for younger juveniles) in the lower four miles of the estuary runs out into the ocean. Near the mouth of the estuary aquatic conditions (*e.g.*, salinity or temperature) are nearly marine. The extent of the upstream effect of these conditions depends upon tidal fluctuation and freshwater inflow from the Russian River main stem and estuary tributaries. Satisfactory freshwater rearing habitat may only be maintained consistently at the upstream end of the estuary and near tributary mouths, where freshwater inflow maintains low salinity conditions regardless of tidal action. The resulting high salinity and low DO at the bottom of the estuary during stratification likely limits food supply for juvenile salmonids rearing in the estuary. In lagoons north and south of the Russian River, temporary loss of estuarine invertebrates (salmonid prey base) was documented, or inferred from steelhead growth rates, each time estuaries closed and stratified (Smith 1990, Cannata 1998, Entrix 2004).[31] Also, as the smaller juvenile stages of steelhead are concentrated in the shallow freshwater lens of a temporarily stratified estuary, they are more susceptible to significant amounts of avian predation. Breaching may also lead to an increase in the amount of pinnipeds (steelhead predators) in the estuary, but increases in marine mammal predation appear to be minor.

Rearing habitat for juvenile steelhead in much of the estuary often remains heavily influenced by the marine environment for months, limiting the amount of YOY and 1 + juvenile steelhead that can successfully use the estuary, due to their low salinity tolerance (Described previously in the *Status of the Species* section). However, these habitat conditions do support larger steelhead juveniles some of which may be "half-pounders" (*i.e.*, post smolt/sub-adult steelhead juveniles that return early from the ocean to rear in river and streams before going out to sea to become spawning adults (Snyder 1925, Kesner and Barnhardt 1972, Fuller *et al.* 2008). Some steelhead in the estuary appear to be small sized mature male adults (Josh Fuller, NMFS, personal observation, 2008). During the twelve year period, 1996-2007, when the estuary closed in the spring, the estuary remained open after breaching for about 90 days on average during the late spring through early fall, ranging between about 44 and 144 days open.

The estuarine rearing habitat conditions for coho salmon are likely worse than for steelhead. High salinity concentrations probably limit habitat availability to the upper estuary below Austin Creek. As noted above, the Russian River estuary has relatively limited marshlands, which coho salmon may prefer as

[30] In early May of 2008, NMFS staff observed the initial stages of a perched lagoon at the mouth of the Russian River. Outflow was occurring southward over the bar until reaching the jetty, where the overflow channel took a sharp turn to the ocean. The freshwater lens appeared to be approximately 6-10 feet deep in the mid and lower portion of the estuary (NMFS unpublished data 2008).

[31] Estuarine invertebrates increased when the lagoons transitioned to fresh water (Entrix 2004).

estuarine rearing areas. Coho salmon have less tolerance for high water temperatures, which likely preclude their use of most of the upper estuary in the summer. Breaching the estuary limits water volume, potentially extending the duration of high water temperatures in the upper estuary.

3. Conservation Role of Specific Habitat Areas within the Action Area

We conducted more site specific analyses for the PCE of CCC coho salmon summer rearing habitat and the PCE of estuarine habitat for CCC steelhead to provide a link between effects of the action and how those effects may affect the role and function of critical habitat at the ESU and DPS scale. This section provides the context for understanding the significance of effects to these critical habitat elements, *i.e.*, how those effects may affect the functionality and ability of critical habitat to serve the intended conservation role for the species or retain the ability of the PCEs to be functionally established.

a. Coho Salmon Juvenile Rearing Habitat.

The Intrinsic Potential (IP) habitat model of historic coho salmon distribution developed by Agrawal *et al*. (2005) indicates that the historic (predevelopment) distribution of coho salmon in the Russian River watershed likely included 710 linear miles of stream habitat[32]. This does not include segments of the main stem which supported seasonal migrations, but were too warm to support juvenile rearing during summer months. This IP habitat model indicates that prior to development in the 18th century, coho salmon were likely distributed throughout most tributaries to the lower Russian River, including the Mark West Creek, Laguna de Santa Rosa, Santa Rosa Creek, Green Valley Creek, Dutchbill Creek, Hulbert Creek, Willow Creek and Austin Creek watersheds, as well as a variety of smaller watersheds tributary to the lower Russian River. CDFG records document coho salmon rearing in the Dry Creek, Mark West Creek and Maacama Creek watersheds as recently as the 1990's. Today the species is almost extirpated from the entire Russian River watershed as the result of the degradation of spawning and rearing habitat, and in the case of Willow Creek degradation of the migratory corridor.

To examine the effect of proposed project operations on the function and role of rearing habitat for coho salmon in main stem Dry Creek, and how these effects impact critical habitat in the Russian River, we estimated the amount of remaining summer rearing habitat for that species in the Russian River and calculated the percentage of that remaining habitat which is represented by Dry Creek. For this we defined the existing amount of summer rearing habitat based on current habitat suitability, water temperature information, and apparent summer rearing survival rates of captive bred coho salmon planted in several streams. We used several sources of information to determine habitat suitability, including: stream habitat typing data (CDFG 2006), the CDFG (2002*a*) definition of the minimum coho salmon distribution, coho captive broodstock monitoring data (UCCE 2007), and other miscellaneous sources of habitat and distribution information.

A principal step in defining the extent of summer rearing habitat for coho salmon was the subtraction of those areas where stream temperatures are, at present, likely to be too warm to support summer rearing of juveniles. We used temperature data primarily from the Russian River Interactive Information System (RRIIS) (Institute for Fisheries Resources 2002 and the Sotoyome Resource Conservation District (RCD) (Laurel Marcus and Associates 2004*a*, 2004*b*, 2004*c*). Where no other data was available, we used data

[32] The calculation of 710 linear miles is based on the intrinsic potential model computations with a water temperature mask eliminating stream segments where mean August air temperature is less than 20.5°C

from the CDFG (2002b) limiting factors analysis for the Russian River basin. Of the streams with continuous temperature data, most had data for at least one summer between 1998 and 2004. The RCD data were summarized into maximum weekly maximum temperatures (MWMT)[33] and we compared this to a threshold of 18˚C. Welsh *et al.* (2001) found that streams in the Mattole River watershed with MWMTs greater than 18˚C did not contain rearing juvenile coho salmon. This conclusion was supported within the CCC coho salmon ESU by Hines and Ambrose (2000). We therefore excluded those streams where temperature data exceeded an MWMT of 18˚C on the basis that they were too warm to provide viable summer rearing habitat. However, if current presence and/or survival data indicated coho salmon were present, or review of other field data indicated coho habitat was likely, we overrode the temperature criteria and included the reach as coho salmon habitat. We did not include areas that currently have unsuitable water temperatures, but that may support coho salmon as the result of future restoration efforts that create suitable temperatures for this species.

We found most of the qualifying summer rearing habitat to be in Mill Creek and its tributaries (Figure 7). Other coho salmon rearing habitats also occur in small portions of Austin Creek, Green Valley Creek, Dutch Bill Creek, Sheephouse Creek, Freezeout Creek, Redwood Creek, Willow Creek, and Hulbert Creek. It is worth noting that some of the segments that we included may have suitable water temperatures for juvenile coho salmon; however, they are currently not inhabited by coho because of habitat degradation such as blocked access (*e.g.*, Willow Creek and Redwood Creek) or impacts from water diversions, channelization, or sedimentation.

The main stem of Dry Creek below WSD is 14.1 miles long. Corps and SCWA (2004) modeled stream temperatures from releases at WSD and estimated median temperatures at the warmest time of year (July) to be 13.2˚C at the dam and 18.3˚C at the confluence with the Russian River. MWMT were not available for Dry Creek, so we concluded that a median temperature of 18.3˚C is likely in excess of the MWMT. However, the temperature gradient from the dam to the confluence was such that most of the stream would fall below the MWMT threshold. We therefore assumed, for the purposes of this analysis, the entire channel down to the Mill Creek confluence would qualify as suitable habitat based on stream temperature. However, we recognize that the quality of rearing habitat in Dry Creek is greatly limited by high velocities associated with high flow releases and limited instream cover.

Our rough estimate of the total number of stream miles of juvenile coho salmon summer rearing habitat in the Russian River is 85 miles, excluding Dry Creek. With Dry Creek there is approximately 98 miles of coho salmon rearing habitat remaining in the Russian River watershed. This remaining habitat is only 14% of the estimated original 710 miles of historic coho salmon habitat in the Russian River watershed. Any adverse effect on summer rearing habitat from flow releases in Dry Creek would therefore affect up to roughly 13 percent of the remaining rearing habitat as measured in river miles.

The actual contribution of Dry Creek as rearing habitat is likely under-represented by a linear analysis, given that Dry Creek is one of the widest streams under consideration . Because of its much greater width than other Russian River tributaries during summer, we factored channel widths in the analysis of available rearing habitat. Cross section data from the main stem of Dry Creek indicates an average wetted channel width of approximately 9.2 meters. Habitat typing data from CDFG (2002*c*) showed variable wetted channel widths for the other streams; therefore, we calculated the weighted average of the mean width of surveyed habitat units, and eliminated dry channel reaches to arrive at an overall wetted channel

[33] MWMT is the seven day moving average of the daily maximum temperature as recorded by in situ temperature data loggers.

area for summer habitat in tributaries. This calculation provided us with an average wetted area estimate of about 282,000 m^2 of wetted channel area in tributaries other than Dry Creek, and 181,800 m^2 of wetted channel area in Dry Creek[34]. Therefore, based on total wetted area, any adverse effect on summer rearing habitat from flow releases in Dry Creek could affect up to roughly 40 percent of the remaining coldwater rearing habitat for coho salmon in the Russian River.

Our results show that Dry Creek has the potential to support up to roughly 40 percent of the summer rearing habitat in the basin, by area. Our limiting factors analysis (described in the *Status of the Species*) indicates that summer rearing habitat is one of the primary factors limiting coho salmon production in the Coastal Diversity Stratum. Because summer rearing habitat is very likely limiting the Russian River coho salmon population, and because Dry Creek represents a significant portion of this habitat, ongoing flow releases from WSD during summer and early fall substantially diminish the function of a large portion of critical habitat to conserve the Russian River coho population, which is a major component of the species' Coastal Diversity Stratum.

[34]These numbers are rough approximations used for general comparisons of relative magnitude. The numbers are not intended to be precise calculations of the actual habitat areas available due to the assumptions and limited data for the calculations.

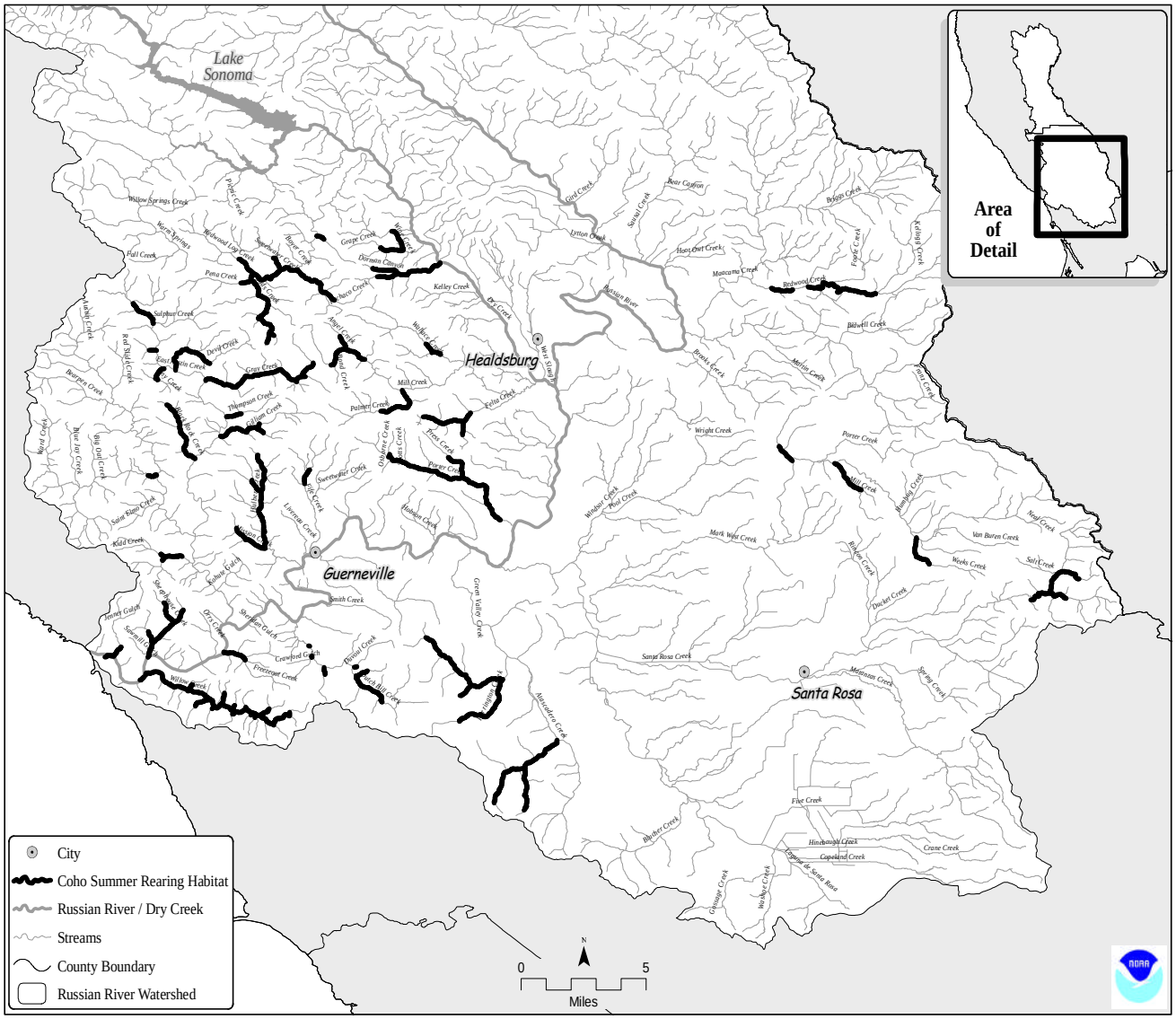

Figure 7. Estimated extent of juvenile coho salmon summer rearing habitat currently present in the Russian River, excluding Dry Creek.

b. Steelhead Estuarine Rearing Habitat.

As detailed in the Life History segment of the Status of the Species section (above), estuarine habitat is important to steelhead as rearing and migration habitat, and is influential in providing growth and survival opportunities as juveniles transition to the ocean phase of their life cycle. Bond (2006) found up to 48 percent of the juvenile steelhead population in Scott Creek had reared in the estuary and that they made up a disproportionate number (85 percent) of returning adults. It is likely that the Russian River estuary historically provided similar functions for steelhead in the basin, though its precise contribution to steelhead productivity in the basin is unknown. Current conditions are not conducive to successful rearing of large numbers of YOY and parr.

The estuary is also valuable in that it is perhaps the only habitat that must support every individual from each of nine populations of Russian River steelhead. With any other PCE of critical habitat, the species is distributed among different habitat patches. For example, while both the Austin Creek and Maacama Creek populations require summer rearing habitat, they may each experience very different habitat quality as a result of being in two different watersheds. Therefore, if something happens to the Maacama Creek habitat, the effect is limited to just that population. On the other hand, if habitat were degraded in the Russian River estuary, it would affect not only the Austin Creek and Maacama Creek populations, but all nine populations in the basin. The Russian River estuary is, in this way, inextricably linked to the recovery of all populations in the Russian River.

The specific habitat functions provided by the estuary include: successful passage of adult migrants upstream, successful passage of smolts migrating to the ocean, successful growth and smoltification of steelhead parr. The estuary must therefore be open to the ocean tides, or perched with enough overflow of the bar, during significant portions of the adult and smolt migration seasons, provide large areas of freshwater rearing space, as well as some areas of brackish and saltwater, and provide for an abundant and diverse invertebrate prey community as a food base for rearing juveniles.

B. Status of Listed Species within the Action Area

The purpose of this section is to: 1) provide a context for the effects analysis at the population scale, and 2) describe the current abundance, distribution, and condition of listed salmonids in the action area. By defining the status of salmonid populations associated with the action area, we are able to establish a link between project effects to individual fish (and/or their habitat) in the action area and a population response. This will, in turn, allow us to evaluate the risk of extinction at the ESU/DPS scale.

What follows is a description of the current condition of the species in the Russian River following the same four population viability metrics used to describe diversity strata in the previous section. Where possible, we describe each species' departure from historical condition and how they are likely to persist into the future.

Throughout this document, we use the historical population structure defined by Bjorkstedt *et al.* (2005) to define existing demographic units. A distinct population is defined as those individuals that spawn and rear in a single watershed that is tributary to the Pacific Ocean. Larger basins were further subdivided into multiple populations if sufficient physical, behavioral, or selective barriers to effective dispersal were evident.

1. Chinook Salmon

Bjorkstedt *et al.* (2005) conclude that a single population of Chinook salmon historically occupied the Russian River. This conclusion is based on the lack of evidence of substantially different selective environments. For example, spawning habitat is relatively contiguous throughout portions of the main stem river and Dry Creek. The spawning population is therefore likely to have been strongly influenced by dispersal from all areas within the basin. In addition, genetic analysis offers little support for the existence of separate populations.

Though there are conflicting reports, the high likelihood of suitable habitat under historical conditions offers strong evidence that a substantial population of fall-run Chinook salmon historically existed in the Russian River (Bjorkstedt *et al.* 2005; Moyle 2002). The historic size of the population remains mostly unknown (Chase *et al*. 2007). Some reports indicate Chinook salmon historically spawned in the upper drainage and were regularly harvested by local tribes in Coyote Valley prior to construction of CVD in 1959 (SEC 1996). However, no scientific observations of Chinook salmon exist in the Russian River prior to initial stocking efforts in the late 1880s. Stocking was performed sporadically through the latter half of the 20th Century, with poor adult returns during the most recent efforts (Chase *et al*. 2007).

SCWA has operated video cameras within the fish ladders at the Mirabel rubber dam in the middle reach of the Russian River for the last seven years. They estimated the Chinook salmon run size at about 1,500 in 2000 and 2001, and observed 5,474 in 2002, 6,103 in 2003, 4,788 in 2004, 2,572 in 2005, 3,410 in 2006, and 1,959 in 2007 (Chase 2005, www.scwa.ca.gov/ environment/ natural_resources/Chinook_salmon.php, SCWA 2008c). These data suggest a possible increase in adult escapement within the last several years. While a positive trend in abundance is an important indicator of viability, given the amount of historic habitat in the basin (548 stream miles, Bjorkstedt *et al.* 2005), it is not likely that the current population has reached a viable state. Smolt trapping just downstream of the Mirabel rubber dam has documented large numbers of Chinook salmon smolts heading downstream. For example, the annual catch in 2002 was 2,705 Chinook salmon smolts. In 2003 the catch was 6,255. A mark recapture study used in 2002 estimated trap efficiency at about 8 percent, resulting in an estimate of approximately 37,000 Chinook salmon smolts (± about 6,000) passing downstream to the Pacific Ocean (Chase 2004). In 2007, the catch was 7,713 smolts. Trap efficiency resulted in an estimate of 126,000 smolts (SCWA 2008d).

Genetic diversity is an important measure of viability as well. Genetic analysis of Russian River Chinook salmon suggests they are not closely related to either the nearby Eel River or Central Valley Chinook salmon, and likely evolved as part of a diverse group of native coastal populations (Hedgecock 2002). A history of hatchery stocking, however, has likely had some effect on genetic diversity (Bjorkstedt *et al.* 2006, Chase *et al.* 2007) (see detailed description in section V.C.8 below).

Although uncertainty regarding the species status warrants caution, there is no compelling evidence of a continued population decline in the Russian River for Chinook salmon, although the 2007 returns suggest caution in drawing this conclusion. The likelihood of the Russian River Chinook salmon's survival and recovery seems fair in light of these indicators. However, water diversions, the confinement of the river channel, limited riparian vegetation, and ongoing sedimentation from roads, agriculture, and other developments remain important unresolved threats to the success of the Russian River Chinook salmon.

The Russian River is the largest watershed in the CC Chinook Central Coastal Diversity Stratum and likely has the largest population. This population is also at the southern extent of the species range. Its extinction would therefore constitute a substantial range restriction, the loss of the largest population in the stratum, and probably the loss of a unique genetic component of the ESU. For these reasons, the survival and recovery of the Russian River population of CC Chinook is important to the conservation of the ESU as a whole.

In the action area, Chinook are known to spawn in the mainstem and Dry Creek, and utilize the estuary during their migrations to and from the Pacific Ocean. Observations of a few Chinook salmon in Santa

Rosa Creek (Part of Zone 1A) and Austin Creek have also been reported (David Manning, SCWA, personal communication, 2008). In the mainstem Russian River (from Riverfront Park in Healdsburg to just north of Ukiah), SCWA surveyed and documented relatively large numbers of Chinook salmon redds in the watershed from 2002 through 2006. In Dry Creek, redds were counted in 2003, 2004, and 2006, between the confluence with the Russian River and WSD. In 2003, 256 redds were observed, with 342 observed in 2004, and 201 observed in 2006 (SCWA 2007a). In the watershed as a whole, the total number of redds observed ranged from 1036 and 1157 in 2002 and 2003 respectively, to 603 in 2006. Most redds were located near Ukiah and in Dry Creek[35]. Many more migrating adults were counted at Mirabel Dam as described above. NMFS assumes that overlapping redds (superimposition), spawning occurring after survey work, spawning outside of the study areas, and the loss of some fish prior to spawning due to predation or illegal fishing are likely explanations for the small number of redds observed compared to adults counted.

A small number of Chinook juveniles and smolts have been documented in the estuary, as described in Section VI.G.2.e.

2. Coho Salmon

Bjorkstedt (2005) conclude that coho salmon existed as two populations in the Russian River; a large independent population in the lower basin, and a smaller ephemeral population that occupied tributaries in the northwest corner of the basin. The lower population represented what was historically the largest and most dominant source population in the ESU.

Information on the historic run size of coho salmon in the Russian River is limited. Late 19th and early 20th Century records are sparse, or non-specific as to species (Chase *et al*. 2007). They once occupied many tributaries throughout the basin, probably reared in backwater areas of the main stem, and were a major component of the fish community (Spence *et al.* 2005). They are now restricted to a few tributaries in the lower watershed (CDFG 2002), and rear only in isolated areas of suitable habitat (see preceding habitat analysis).

Various sampling methods were used to determine juvenile coho salmon presence/absence within several tributaries of the Russian River during the summers of 1992 through 2007 (Conrad and White 2006; M. Obedzinski, U.C.Davis Extension, personal communication, 2007). Both the abundance and distribution of juvenile coho salmon in the Russian River basin have declined precipitously in recent years (Conrad and White 2006). Since 2001, wild juvenile coho salmon presence has been confirmed by the RRCSCBP in only five of the 32 historic coho streams (referenced in Brown *et al.* 1994). Presence data has been collected during broodstock collection efforts and monitoring survey work and indicates that wild juvenile coho salmon were recently present in Green Valley Creek, Dutch Bill Creek, Mark West Creek, Redwood Creek (tributary to Maacama Creek) and Felta Creek (tributary in Dry Creek watershed) in low numbers, and were often only present in intermittent years. More recently, only three (Green Valley, Dutch Bill, and Felta creeks), of the 32 historic coho salmon streams within the Russian River (referenced in Brown *et al.* 1994) had confirmed wild juvenile coho salmon and only in intermittent years (Conrad and White 2006).

[35] The amount of redds in Dry Creek suggests that the lack of instream cover and complexity described may not be limiting for Chinook salmon spawning.

Three consecutive year classes of coho salmon were present in Green Valley Creek from 2001 through 2004, however, wild YOY coho salmon have not been detected in Green Valley Creek since 2004 (M. Obedzinski, U.C.Davis Extension, personal communication, 2007). Since YOY coho salmon have not been detected for three consecutive years, this may indicate that wild coho salmon have been extirpated from Green Valley Creek.

Genetic analyses of coho salmon sampled from Russian River tributaries are consistent with what would be expected for a population with such extremely reduced abundance. A review by Bjorkstedt (2005) found both strong departures from genetic equilibrium and evidence of recent, severe population bottlenecks. Historical hatchery practices may also have contributed to these results (described in section V.C.8 below). This evidence suggests an acute loss of genetic diversity for the Russian River coho salmon population.

The RRCSCBP was initiated in 2001 to reestablish self-sustaining runs of coho salmon in tributary streams within the Russian River Basin (Obedzinski *et al.* 2007). Under this program, offspring of wild captive-reared coho salmon are released as juveniles into tributaries within their historic range with the expectation that a portion of them will return to these areas as adults to naturally reproduce. These juveniles have been released into the following tributaries in the Russian River basin: Sheephouse Creek, Mill Creek, Palmer Creek, Ward Creek, Gray Creek, Gilliam Creek, Dutch Bill Creek, and Green Valley Creek (see Table 19 below).

The first returns of adult coho salmon were expected to return to release streams during the 2006/07 spawning season. Adult spawning survey efforts conducted by the RRCSCBP in the release streams during the 2006-07 spawning season only resulted in confirmation of one returning adult female coho salmon to Mill Creek. Although this program represents an important component of conservation and recovery efforts for Russian River coho salmon, the benefits of the program have not yet been realized.

Based on its decline in abundance, restricted and fragmented distribution, and lack of genetic diversity, the Russian River population of coho salmon is likely in an extinction vortex, where the population has been reduced to a point where demographic instability and inbreeding lead to further declines in numbers, which in turn, feedback into further declines towards extinction (Frankham *et al.* 2002). The Russian River population itself is in the middle of the CCC coho salmon ESU's range and inhabits a watershed that represents fully a third of the ESU by area. For these reasons, irrespective of the condition of the watershed, the Russian River has great potential to provide important geographic continuity, diversity, and habitat space for the species. The continued existence of CCC coho salmon in the Russian River is therefore significant to the survival and recovery of the entire ESU.

The few coho salmon that remain in the Russian River watershed use the Russian River mainstem and estuary primarily as a migration corridor. They are not present in the Zone 1A streams considered in this biological opinion. The estuary, mainstem Russian River, and Dry Creek are used by adult coho salmon migrants in the late fall and winter, and by smolting juveniles in the spring. Residence time in the estuary by smolting juveniles is likely short (see below in the *Effects of the Proposed Action* section). Very small numbers of YOY coho salmon may attempt to rear in the estuary for longer time periods. Some coho juveniles born in Dry Creek tributaries likely attempt to rear in Dry Creek but are unable to due to high flows and limited cover, as described in the *Effects of the Proposed Action* section.

3. Steelhead

The Russian River historically supported nine separate populations of steelhead in two diversity strata (see *Status of the Species* above). Austin Creek, Dutch Bill Creek, Green Valley Creek, Mark West Creek, Dry Creek, Maacama Creek, and Sausal Creek all represented distinct populations. The remaining tributaries were lumped into Upper and Lower Russian River populations respectively. In total, these populations represented one of the two most productive regions in the ESU (along with San Francisco Bay tributaries) (Bjorkstedt *et al.* 2005).

Situated at the northern extent of the CCC steelhead ESU's range, the Russian River was renowned as the third largest steelhead river in California during the first half of the 20th Century (SEC 1996). However, similar to coho salmon and Chinook salmon, historical and current data on run sizes are limited or non-existent. SEC (1996) reported historic Russian River catch estimates for steelhead: 15,000 for the 1936 sport catch, and 25,000 for the 1956/57 sport catch. These estimates are based on best professional judgment by a CDFG employee and, for the latter estimate, a sportswriter. Other estimates include one of 57,000 steelhead made in 1957 (SEC 1996). Assuming the characterization of the Russian River as the third largest steelhead stream in California in the mid 20th Century is reasonable, the estimates above are likely roughly accurate, indicating tens of thousands of steelhead inhabited the Russian River in the early and mid 20th Century. Since the mid 20th Century, Russian River steelhead populations have declined. Estimates based on best professional judgment infer a wild run of 1,700- 7,000 fish near the end of the 20th Century (McEwan 2001). Hatchery returns averaged 6,760 fish for the period 1992/93 to 2006/07, and ranged from 2,200 to 11,828 fish. The information available suggests that recent basin-wide abundance of wild steelhead has declined considerably from historic levels.

As described elsewhere in this document, the Russian River has received out of basin steelhead stock in large numbers and from a wide variety of sources as far back as the late 1800s (SEC 1996). Since 1982, fish have been collected from the CVFF and at WSD, and reared at the DCFH. Differentiation among steelhead within the Russian River basin has been substantially influenced by the widespread transfer of hatchery steelhead within the basin (Bjorkstedt *et al.* 2005). However, the degree to which this influence has resulted in degradation of genetic diversity within the basin is unclear.

Despite declines in abundance, steelhead remain widely distributed within the basin (NMFS 2005*b*). The primary exceptions to this are the barriers to anadromy caused by CVD and WSD. CVD has blocked approximately 21 percent of the historical habitat of the Upper Russian River population, and WSD has blocked approximately, 56 percent of the Dry Creek population's historical habitat (Spence 2006).

Certain aspects of the steelhead life history (detailed in the *Status of the Species* section) have afforded it greater resistance to extinction. For example, juveniles are able to tolerate a wider range of habitat conditions than most salmonids. This has allowed them to survive where others cannot (in very low numbers in portions of constructed flood control channels in Zone 1 A, for example). One apparent adaptive strategy however, appears to have created a challenge to their recovery. The habit of rearing in the estuary affords significant growth opportunities to that portion of the population which spends some or all of its time doing so, rather than in the stream environment (Bond 2006; Hayes *et al.*2006). The propensity for estuarine rearing appears to increase with populations in more southern latitudes and may be an adaptation to reduced instream growth opportunities in more arid regions where summer rearing habitat may be limited. Steelhead parr in the Russian River have been detected moving downstream

towards the estuary (Chase 2005; Katz *et al.*2006) in quantities sufficient to suggest that a significant portion of the Russian River populations attempt to rear there. Rearing conditions for YOY and parr in the estuary, however, are poor. This, in combination with degraded habitat upstream, is likely a major determinant in maintaining the current depressed population levels.

The Russian River populations of steelhead are important to the survival and recovery of CCC steelhead for several reasons. First, because they were historically among the primary source populations for the DPS, they presumably still have the potential to play that important role in supporting the survival and recovery of the DPS. Second, since the Russian River lies at the northern extent of the CCC steelhead range, it supports an important component of the species geographic distribution. And third, because the basin is so large, it supports a significant diversity of habitats, from wet coastal to arid interior environments, which potentially foster important diversity components for the species. The continued survival of Russian River steelhead is therefore integrally important to the overall survival and recovery of the CCC steelhead DPS.

The action area for this project is used by steelhead for migration (most of the action area), spawning (most of Dry Creek, some areas of the mainstem and Zone 1A, as well as many areas in other tributaries). For example, about 46 steelhead and 43 steelhead redds were observed in approximately 2 miles of Dry Creek in 1999 (NMFS unpublished data, 1999b)[36]. Juvenile steelhead rear throughout the Russian River basin. The density of rearing steelhead in particular areas is strongly influenced by the condition of rearing habitat.

Although aquatic habitat in the mainstem, Dry Creek, Zone 1A, and the estuary is in degraded condition for juvenile rearing, juvenile steelhead continue to inhabit these areas in low numbers. In the mainstem, SCWA surveyed juvenile steelhead abundance in distribution in the summer of 2001 from Ukiah downstream to Healdsburg. A total of 1,436 steelhead in 11.5 miles of total channel length surveyed, or 0.07 steelhead per yard, were observed. Densities ranged from a high of 0.2 steelhead per yard to as low as 0.03 steelhead per yard (SCWA 2003). The largest number of juvenile steelhead were found between Hopland and Cloverdale.

Downstream of Healdsburg, more limited sampling efforts show very low densities of juvenile steelhead in the mainstem during the summer, reflecting the highly degraded habitat conditions for summer rearing in this area of the the mainstem. For example, 5 steelhead were found in the 3 mile area inundated by the Wohler Pool in 2003 (SCWA 2004a). One juvenile steelhead was relocated from the fish ladder construction area for the Healdsburg summer dam (SCWA 2001b). In the estuary, seining efforts have documented low numbers of juvenile steelhead during the summer, as described in the *Effects of the Proposed Action* section.

In the action area portion of Zone 1 A, steelhead are still present in the Mark West Creek watershed including the Laguna de Santa Rosa, Copeland Creek, Brush Creek, Santa Rosa Creek, Paulin Creek, Windsor Creek, Blucher Creek, Crane Creek, and Matanzas Creek. Juvenile densities are very low in the constructed flood control channel portions of these creeks. Higher densities are found in natural waterway areas such as the Mark West Creek mainstem and portions of Santa Rosa Creek. For example, the constructed flood control channel reach in downtown Santa Rosa is dominated (numbers) by sculpin, with

[36] Dry Creek has not been surveyed for steelhead spawners and redds on a consistent basis. NMFS expects conditions in Dry Creek are good for steelhead spawning in many years.

steelhead densities ranging from 0.01 fish per square meter to 0.03 fish per square meter. Upstream of Spring Lake in the natural waterway portion of Santa Rosa Creek, juvenile steelhead were more numerous than other fish species with densities of 0.01 to 0.66 per square meter (SCWA 2002).

Most of the steelhead juveniles found in the constructed flood control channels are likely from spawning areas upstream in natural waterways. After emergence from spawning gravels, juvenile steelhead are known to move downstream disperse in streams seeking rearing areas. Some move downstream, as described above in the *Status of the Species* section. Those entering flood control channels are likely to encounter degraded baseline habitat conditions, and many of these fish will not survive, resulting in the low densities reported above.

C. Factors Affecting Listed Salmonids and Their Habitat within the Action Area

Threats to ESA-listed salmon and steelhead are numerous and varied. Among the most serious and ongoing threats to the survival of Russian River salmon populations in the action area are changes to natural hydrology, habitat degradation and habitat loss. Much of the Russian River watershed is affected by multiple human factors. Some of these anthropogenic factors are related to activities undertaken or authorized by the Corps or SCWA, but many factors are independent of the Corps or SCWA. Factors related to the Corps or SCWA projects which will be carried out into the future as part of the proposed action are discussed briefly in this section as it relates to current population and habitat conditions. We provide a more detailed analysis of those same factors in the Effects of the Action section of this document and relate the factors to likely future effects on species and critical habitat. Also, separately, we discuss factors not related to Corps or SCWA projects and naturally-occurring events, such as droughts or variation in ocean productivity, which affect salmonids and their habitat. The following discussion provides an overview of the types of activities and conditions that adversely affect salmon and steelhead populations and designated critical habitat in the Russian River watershed.

1. Coyote Valley Dam Operations

With the completion of CVD in 1959 on the East Fork of the Russian River access blocked up to 143 miles of salmonid spawning and rearing habitat (Corps 1982, Prolysts 1984, CDFG 2002). The habitat lost upstream of CVD was considered to be some of the highest quality habitat available for salmon and steelhead spawning and rearing (SEC 1996). Prolysts (1984) estimated annual steelhead productivity lost in the East Fork of the Russian River following placement of the CVD ranged from 2,213 to 7,685 adult fish and 51,465 to 178,721 wild, ocean-bound smolts (Prolysts 1984).

Construction of CVD also reduced sediment supply to the main stem Russian River. The SCWA estimates that the CVD has trapped about 21,000 tons of sediment per year from the 105 square mile watershed that drains to Lake Mendocino (Florsheim and Goodwin 1993). This reduction in sediment transport downstream of CVD contributes to channel incision and increases in erosion of stream banks in reaches below the dam as the river attempts to adjust to equilibrium (Corps 1997). The gravel retention by CVD coupled with sediment deficits from gravel extraction has caused channel incision in the main stem and tributaries of the Ukiah Valley.

Operation of CVD by the Corps since 1959 has provided flood protection for areas below the dam and supplies water for domestic and agricultural uses (Corps and SCWA 2004). The Corps's objective during

flood control operations is to prevent flows from the East Fork of the Russian River from contributing to flows that cause flooding in the Ukiah and Hopland areas to the extent possible (Corps and SCWA 2004). The Corps limits releases from CVD to prevent flooding at Hopland that can occur when flows exceed 8,000 cfs. Specific criteria for flood control for flood control operations are described in the CVD Water Control Manual (Corps 1998).

CVD affects the natural hydrology in the main stem river below the dam by reducing the peak flood discharge and storing runoff and then releasing the storage between storms (Florsheim and Goodwin 1993). Releases from the flood control pool typically extend the periods of high flows when they would otherwise be receding. A Corps study of the 1964 flood indicated that CVD reduced peak flows at Hopland by 29 percent, 14 miles downstream, reduced the flows at Cloverdale by 21 percent, 30 miles downstream, and 7 percent at Guerneville, 74 miles downstream (Corps and SCWA 2000*a*). Florsheim and Goodwin (1993) report that the duration of the flood flows for the 1964/65 flood and the 1986 floods were increased by 4 days in 1964/65, and 6 days in 1986.

CVD has less effect on more frequent flood events such as the 1.5 year event in the main stem Russian River. The dominant discharge for a 1.5 year event at Hopland was approximately 14,500 cfs in an unregulated condition and 9,500 cfs with flood control provided by CVD (Corps and SCWA 2000*a*). At Healdsburg, the effects of CVD winter flood flow regulation are negligible, with a flow for a 1.5 year event of about 25,000 cfs for the regulated and unregulated condition.

Corps and SCWA (2000*a*) identified four potential issues related to flood control operational effects on salmonid habitat conditions. These issues include the potential for flood releases to scour spawning gravels, potential to contribute to stream bank erosion, high and persistent turbidity levels in the main stem, and potential effects to channel forming/geomorphic flows that may affect salmonid habitat. In addition to these potential effects, Corps and SCWA (2000*a*) reviewed the effects that dam ramping rates (flow increases or decreases over time) may have on salmonids and their habitat, as well as the effects of annual and periodic inspections on listed species.

Scour impacts from CVD releases of 1,000 to 6,400 cfs may have sufficient stream power to mobilize streambed sediment that could result in scour of salmonid redds. The discharge that typically mobilizes the streambed is referred to as the dominant discharge and has a recurrence interval of 1.5 to 2 years on average (Mount 1995; Florsheim and Goodwin 1993). The dominant discharge that is likely to be sufficient to mobilize the streambed is approximately 4,200 cfs in the upper Russian River in the Ukiah Valley. In years when we expect natural channel forming flows to occur (wetter winters) CVD usually makes releases that contribute to a longer duration of channel forming flows due to prolonged post storm releases. CVD operations also decrease very large peak flood flows that may contribute to scour of salmonid redds on the upper Russian River. Although CVD increases the duration of flows that have the ability to mobilize the streambed, Chinook salmon and steelhead redds are typically constructed in areas of low mobility, and have a lower risk of being scoured to the depth of the egg pocket (May *et al.* 2007). The current channel conditions in the upper main stem such as incision, and dense riparian vegetation may have caused some increased probability of redd scour due to increased shear stress on the channel bed.

Bank erosion impacts due to flood operations of CVD were assessed by Entrix (Corps and SCWA 2004). The Entrix analysis, with hydrologic data provided by the Corps, 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. Prolonged dam releases in the past have likely exacerbated bank sloughing due to channel incision and have resulting bank adjustments from Ukiah to Hopland.

Flood control ramping rates have been identified as a potential cause of stranding of juvenile salmonids, and can dewater salmonid redds if flow and stage elevations change rapidly. Between 1959 and 1998, the only restrictions to dam tenders at CVD were that releases could not change more than 1,000 cfs per hour to prevent bank sloughing in downstream reaches. In 1998, with the Federal listing of CCC coho salmon, the Corps and NMFS developed "interim ramping rates" to minimize effects to listed salmonids, until Section 7 consultation could address the effects from dam operations in the Russian River.

CVD has conducted pre-flood and periodic maintenance inspections since the early 1960s. These inspections occurred during the summer or fall and require flow cessation from the facility. Prior to 1998 these inspections were conducted with little regard to potential effects to aquatic resources downstream. Surveys from 1998 through 2004 have determined that adverse effects occur as a result of these inspections. Adverse effects occur with the minimization measures followed by the Corps that are set forth in NMFS biological opinions for these actions. Based on the results of these recent surveys of the three miles of the main stem below the confluence with the East Fork Russian River, NMFS concludes that many juvenile steelhead were likely impacted during the dam inspections that occurred from 1960 to 1998. Many juvenile steelhead residing in the upper three to four mile reach of the main stem where likely stranded, and may have perished. Currently the Corps follows strict ramp down procedures and other terms and conditions that minimize the take of listed species during these inspections.

From late spring through mid-fall, when precipitation and runoff are minimal, stream flow in the main stem Russian River is governed by releases from CVD and WSD. During this period, flow releases from CVD largely provide the surface flow in the main stem upstream from the confluence of Dry Creek at Healdsburg. From Healdsburg to the Russian River mouth at Jenner, main stem flow is the result of the combined releases of CVD and WSD. During the low flow season, releases from the two dams are operated under the management of SCWA for the purpose of water supply in accordance with SWRCB Decision 1610 (D1610). Under D1610, required minimum flows in both the upper and lower Russian River vary depending upon defined water supply condition (see Figure 1, and *Description of the Proposed Action* above).

Elevated summer flows have affected the following salmonid habitat PCEs in the main stem Russian River; 1) freshwater rearing habitat of steelhead and Chinook salmon, 2) estuarine rearing, 3) adult migratory habitat of Chinook salmon; and 4) spawning habitat of Chinook salmon. Past CVD summer flow operations have likely had little adverse effect spawning and migration of steelhead and coho salmon in the main stem Russian River due to timing of spawning of these species.

Under the constraints of D1610, flow management at CVD, creates stream discharges that provide limited amounts of rearing habitat for juvenile steelhead in the 34 mile segment between the dam and Cloverdale. During summer and fall, flow releases from this dam far exceed those that support optimal conditions for steelhead rearing. D-1610’s normal-water year minimum requirement of 185 cfs for April 1 through August 31 in the segment between the East Fork and Dry Creek necessitates the release of about 250 to 290 cfs from CVD. Such high flow releases are needed because a cumulative total of about 50 to 100 cfs is diverted from this segment each day by numerous municipal, residential, and agricultural interests.

These diversions eventually diminish the river's flow until it approaches the minimum requirement of 185 cfs at Healdsburg just upstream of the mouth of Dry Creek. The elevated flow conditions associated with these current operations create current velocities that limit the available rearing habitat for juvenile steelhead and juvenile Chinook salmon.

Main stem flow releases required to maintain requirements of D1610 also cause the coldwater pool in Lake Mendocino to become depleted by late August or early September, reducing the quality of rearing habitat in the upper main stem Russian River. As discussed in Section V.A.2, the segment downstream from Cloverdale does not support significant summer rearing habitat for steelhead because of relatively high water temperatures. Effects of high flows from CVD on salmonid habitat are described in more detail in the Effects Section VI.F of this opinion.

In contrast to the adverse affects to summer and fall rearing habitat, current flow management under D1610 provides good migration and spawning habitat conditions for adult Chinook salmon in the main stem Russian River. The elevated flows in the late summer and early fall ensure that the mouth of the river is open for migration of adult Chinook salmon. Flow releases also ensure abundant available spawning habitat for Chinook salmon in the fall.

Although releases from CVD provide some salmonid habitat in the upper Russian River, releases from this dam likely contribute high and persistent levels of turbidity to the main stem Russian River. The dam releases water from near the bottom of Lake Mendocino. Turbidity can remain high at the bottom of the lake after inflow and/or the lake's surface has cleared, mainly because of the depth of the lake, the small size of the sediment particles[37], turbidity currents[38], and releases from the bottom of the lake. Following rainstorms, NMFS staff conducting an overflight of the area observed turbid water being released from Lake Mendocino even though water entering the lake was clear (B. Cluer, NMFS, personal communication, February, 2007). Information from the mid-late 1960s also indicates the potential for persistent turbidity from CVD releases. Ritter and Brown (1971) found that the CVD increased the amount of time required for the East Branch of the Russian River to transport over half of its suspended sediment load by 2-3 times, lengthening the amount of time turbid water flows downstream into the main stem Russian River. The time needed to transport 90 percent of the sediment load increased by a factor of 10.

The potential duration of turbid water in releases from the CVD is a particular concern for both salmonids and their habitat. The longer sediment remains in downstream flows, the higher the likelihood suspended sediment will occur when flows are low in the main stem (between storms or after storms end in the late spring). Most salmonid adults and juveniles migrate during these times (adults between storms and juveniles in the spring), potentially increasing their exposure to turbidity from CVD releases. In addition, when suspended sediment occurs at lower flows, there is more opportunity for sediments to drop out of these slow and shallow flows and accumulate[39] throughout the channel, including in riffle and pool areas

[37] Storm flows entering Lake Mendocino have a high concentration of suspended sediment in the form of small clay particles. Because the clay particles are very small, they are slow to settle out of the water column and remain in the water column for protracted periods.

[38] Sediment laden water entering a lake can be denser (heavier) than lake water. If so, the denser sediment laden water moves toward the bottom of the lake. (Ritter and Brown 1971).

[39] As flows decrease, the river loses the power to transport sediment. The larger sized particles drop out first followed by smaller sized particles as flows continue to recede. When most sediment is transported at high flows, it is more likely to settle out at the edges of the channel where backwaters and eddies create low flow areas.

in the low flow channel. Turbidity from CVD may be causing delay harm to eggs and alevins, and limiting rearing opportunities by reducing feeding, displacing rearing juveniles downstream, reducing growth rates for rearing salmonids, and reducing their food supply.

Unfortunately, data are not available to accurately estimate the relative contribution of turbidity from CVD to the current turbidity and sediment loads in the Russian River. As described elsewhere in the *Environmental Baseline*, sedimentation and turbidity in the Russian River come from a variety of factors, including agriculture and development. Data on the relative amount of turbidity and sedimentation from each factor are lacking. Although the Russian River watershed was found to clear fairly rapidly after major storms in the mid-late 1960s (Ritter and Brown 1971), this may not always be the case today.

2. Warm Springs Dam Operations

Located 14 miles upstream from the mouth of Dry Creek, WSD blocks anadromous fish access to 50 to 105 miles (Cramer *et al*. 1995) of the Dry Creek watershed. The dam and its 381,000 acre foot (ac-ft) reservoir regulate year round stream flow in Dry Creek, providing substantially augmented stream flows during historic low flow periods and reducing the magnitude of high flows during winter storm events. The dam and its reservoir have also appreciably altered the dynamics of Dry Creek's sediment transport and the condition of the creek's riparian vegetation. Historically, lower Dry Creek was an intermittent stream, with isolated pool remaining in the summer. After the construction of WSD in 1983, Dry Creek became a perennial stream.

During the winter months WSD is operated for flood control, which reduces peak flood discharges in Dry Creek and the Russian River by storing runoff in Lake Sonoma (Corps and SCWA 2004). Prior to construction of WSD, flows of 5,000 cfs (channel forming flows, Corps and SCWA 2004) occurred in 60 percent of the years reviewed by NMFS. Since construction, flows exceeding 5,000 cfs only occur in about 14 percent of years. Lake Sonoma has a 130,000 ac-ft flood control capacity, which is sufficient to store watershed runoff from a 100-year, 6 day flood event. The Corps determines releases from the reservoir when lake elevation is above 451.1 mean sea level. Warm Springs flood operations are controlled by criteria set forth in the Warm Springs Dam Water Control Manual (Corps 1998). The Corps attempts to avoid flood releases from the dam that exceed 6,000 cfs, and to the extent possible manages releases to help limit flows on the Russian River at Guerneville to 35,000 cfs. Flow ramping rates for flood operations since 1998 have followed an interim ramping schedule agreed to by the Corps and NMFS.

WSD has altered the hydrologic regime and geomorphic conditions of Dry Creek. An example of the project's value in reducing peak flows is reported in EIP (1994), which compare the maximum pre-dam flood of 32,400 cfs in January 1963 with the maximum post dam peak flow in Dry Creek of 5,280 cfs. The floods of 1963 and 1986 on Dry Creek were of comparable size, which demonstrates that WSD can reduce peak flood by as much as 83 percent (EIP 1994 as cited in Corps and SCWA 2004). Similarly, a 1.5 year peak flow prior to dam construction was 11,000 cfs, and now is reduced to about 2,500 cfs in the post dam condition (Corps and SCWA 2004).

Even with the reduction to peak flow, releases from WSD may be sufficient to mobilize the streambed and impact salmonid spawning areas below the dam. In addition to potential redd scour, the Corps and SCWA (2004) evaluated the potential for these operations to initiate bank erosion, to decrease flushing flows that

are needed to maintain spawning habitat suitability, and the potential impacts that flow ramping releases may have on salmonids in Dry Creek.

Spawning gravel or redd scour potential was analyzed by Corps and SCWA (2004) for Dry Creek with respect to coho salmon, Chinook salmon, and steelhead trout. According to Corps and SCWA (2004), current flood operational releases provide for a balance between periodic mobilization of the streambed needed to flush spawning gravel, and the scour that can destroy salmonid embryos in redds. Although WSD flood releases that exceed 5,000 cfs may be sufficient to cause some scour of coho salmon and Chinook salmon redds, the overall frequency of flows that scour redds is decreased as a result of WSD operations. Scour flows that exceed 5,000 cfs occurred more often in Dry Creek before the dam was constructed, and occur at a reduced frequency since WSD has been in operation. Scour of steelhead redd sites are less likely to be affected because most of their redds are constructed later in the spawning season as compared to coho salmon and Chinook salmon.

In general, maintenance of channel geomorphic conditions which maintain sediment transport and flushing of fine sediments should occur about once every two or three years (Corps and SCWA 2004). Channel forming flows in Dry Creek are 7,000 cfs below Pena Creek and 5,000 cfs between Pena Creek and the WSD. These channel forming flows are achieved in Dry Creek about once every six years (Corps and SCWA 2000*a*). Analysis conducted as part of Corps/SCWA's BA indicates that flows below WSD may be insufficient to maintain geomorphic conditions. WSD flood releases that exceed 5,000 cfs have an effect on spawning gravel quality below the dam, but must be weighed against the effects of redd scour and loss of sediment transport due to the presence of the dam.

Bank erosion along Dry Creek below WSD is initiated at flows above 2,500 cfs. Bank erosion analysis conducted by Entrix indicates that the potential for flood releases that would initiate bank erosion is low for most years, but not in all years (Corps and SCWA 2000*a*). Flood releases are generally low during periods when natural flow accretion from Dry Creek and tributaries is above the 2,500 cfs threshold that initiates bank erosion. From 1983 to 1995, WSD flows exceed 2,500 cfs for three or more days only four times, or about 25 percent of the time during the flood season. When flows over 2500 cfs are released from WSD it is expected that they likely contribute to bank erosion along Dry Creek. Some adverse effects associated with bank erosion have likely occurred to salmonid spawning areas with localized increases in fine sediment that reduces embryo or alevin survival within redds. Some potential benefits associated with bank erosion may occur when organic debris enters the channel and provides improved rearing habitat conditions for juvenile salmonids.

Ramping of flow for flood control has the potential to adversely affect salmonids by stranding juvenile fish when large river stage elevation changes occur. NMFS has used the Washington Department of Fisheries ramping criteria (Hunter 1992) as an indicator for potential effects of ramping rates for operations such as WSD and CVD. Evaluation of stage-discharge data were analyzed by Corps and SCWA (2000a) for Warm Spring Dam releases of 250 cfs per hour, and 125 cfs per hour. Results for WSD ramping rates indicate that ramping rates of 250 and 125 cfs do not meet the Hunter Criteria of 0.32 feet per hour (ft/hr). Stage elevation changes in Dry Creek are about 0.5 ft/hr and data indicate that the stream reach closest to the dam are most susceptible to stage changes. Stream reaches further downstream from the dam (below Pena Creek) meet the criteria for juvenile salmonids. Potential effects to juvenile salmonids are most likely to occur from Pena Creek upstream to the outlet of WSD, a 1.5 mile reach. Prior to the interim ramping rates that were agreed to with NMFS in 1998, stranding likely occurred in the

reach below the dam due to less protective releases from the dam. The interim ramping rates that have been in place since 1998 have increased protection for juvenile salmonids, but analysis provided in Corps and SCWA (2000*a*) indicates that adverse effects in the form of stranding may be occurring between the outlet of WSD and Pena Creek.

Lake Sonoma is the principal water supply for much of Sonoma County's urban and residential population during the extended low flow season (*e.g.*, generally late May through October). SCWA obtains this water by releasing it at WSD where it flows down Dry Creek, enters the Russian River and then flows downstream to SCWA's principal diversion and treatment facilities located along the Russian River at Mirabel and Wohler. This system of transmitting water from Lake Sonoma to SCWA's diversion facilities on the Russian River via Dry Creek has greatly increased flow in Dry Creek during the summer months compared to conditions prior to construction of WSD. This change in flow regime for the 14 mile segment of Dry Creek below the dam has greatly altered habitats for steelhead, coho salmon, and Chinook salmon.

Before WSD was constructed, summer flows in Dry Creek were generally about 1 to 3 cfs during late summer; in several years, late summer flows below the confluence of Pena Creek were less than 1.0 cfs (published data for USGS gage No. 11465200). Summer flows in Dry Creek are markedly different today. SCWA operates WSD consistent with SWRCB D1610, which in normal years requires a continuous minimum flow of 80 cfs between WSD and the mouth of Dry Creek from May 1 to October 31. For dry years, D1610 requires a minimum flow of 25 cfs in Dry Creek between April 1 and October 31. D1610 stipulates the minimum flow to be maintained; however, the actual flow in Dry Creek during summer is dependent upon water demand (USACE and SCWA 2004). It can vary substantially with occasional releases as low as 25 cfs or as high as 180 cfs, but since 1995 it has been in the range of about 110 to about 130 cfs. However, during the past two years (2006 and 2007) the median monthly flow in Dry Creek during July through October has generally ranged between 97 and 105 cfs. Figure 8 depicts representative stream flows between July and October during the past fifteen years. Table 15 shows the median values for the average daily flow during summer months between 1992 and 2005

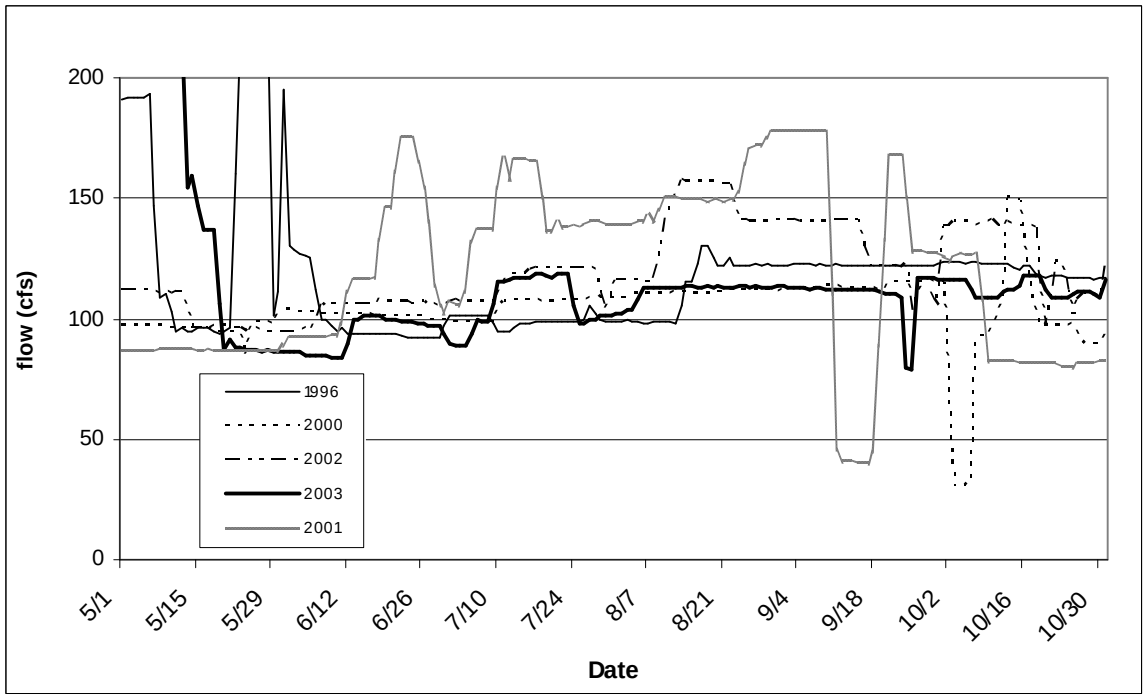

Figure 8. Representative water releases at Warm Springs Dam during summer months. Source: USGS Gage 11465000

The water released from Lake Sonoma is of a high quality that supports salmonid species. Corps and SCWA (2004) explain that the water released from WSD is managed for its use in the Don Clausen Fish Hatchery, where it is monitored for turbidity, suspended sediment concentrations, temperature, and dissolved oxygen. These water quality parameters are managed by mixing water from the low-flow tunnels that draw water from different levels of Lake Sonoma. Corps and SCWA (2004) report the results of flow and stream temperature modeling for Dry Creek for alternative water management scenarios. The Russian River Water Quality Model indicates that water released from WSD is cold and favorable for anadromous salmonids, and that temperatures remain cold along the 14 mile segment below the dam (Table 16). Temperature monitoring 500 feet below WSD (USGS Gage 11465000) between 1985 and

1993 document that the water released from Dry Creek is cold (Table 17). Dry Creek temperatures and the related requirements of steelhead and coho salmon were previously considered in Section V.A.2 above.

Table 15. Median value of the mean daily flow (cfs) in Dry Creek immediately below the WSD for each month during the low flow season 1992-2007. Source: USGS Gage 11465000

Water Year & succeeding October	June	July	August	September	October
1992	116	118	109	109	103
1993	104	128	133	116.5	99
1994	136	146	148	104	101
1995	90	92	100	97	97
1996	94	99	122	122	121
1997	97	154	152	103	96
1998	305	100	100	101	101
1999	92	94	102	108	108
2000	102	108	111	113	97
2001	115	139	149	128	82
2002	106	119	141	135	139
2003	97	105	113	112	111
2004	121	102	110	111	104
2005	135	114	116	106	111
2006	92	102	103	103	100
2007	123	97	97	102	--

Table 16. Estimated median temperatures (^{o}C) in Dry Creek under current demand levels for all water supply conditions combined (Source: Corps and SCWA 2004).

Station	June	July	August	September	October
Below WSD	13.2	13.2	13.1	13.1	12.9
Lower Dry Creek	17.8	18.3	17.9	16.8	15.1

Table 17. Monthly minimum and maximum water temperatures (°C) 500 feet below WSD during summer months 1985-1993 (data from USGS Gage 11465000).

	June		July		August		September	
Year	Min	Max	Min	Max	Min	Max	Min	Max
1985	10.0	11.5	10.5	11.0	10.0	11.0	10.0	10.5
1986	12.0	12.5	11.5	12.5	12.0	12.5	11.5	12.5
1987	13.5	15.5	12.0	16.5	12.0	14.0	14.0	16.0
1988	10.0	10.0	10.0	10.5	10.5	16.0	10.5	15.0
1989	11.0	11.5	11.5	12.0	10.0	12.5	10.0	12.0
1990	11.0	11.5	11.5	12.5	12.0	14.0	n/a	n/a
1991	11.0	16.0	11.0	11.5	11.0	11.5	10.0	12.0
1992	12.5	13.0	13.0	14.0	11.5	14.0	11.0	12.0
1993	n/a	n/a	11.5	12.0	12.0	13.0	12.5	13.5

Prior to the construction of WSD in 1983, Dry Creek contributed the most sediment of any Russian River tributary (Ritter and Brown 1971). Goudey *et al*. (2002) report that the gravel bed streams within the Dry Creek watershed are capable of transporting large amounts of sediment composed of Quaternary alluvium. Extraction of these high quantities of gravel began in the 1900s in the lower reaches of Dry Creek. This activity has caused considerable geomorphic changes in Dry Creek, particularly since 1940 when intensive gravel extraction was occurring along the Middle reach of the Russian River (Swanson 1992). Gravel continued to be extracted from Dry Creek until 1979 (Corps and SCWA 2004). Geomorphic changes were documented by the Corps 1987 that concluded that past gravel extraction operations on Dry Creek and the main stem Russian River had caused 10 feet of channel incision along 14 miles of Dry

Creek (Corps and SCWA 2004). This channel incision initiated lateral instability and bank erosion changing the channel width from 90 feet to over 450 feet in some areas in the 1970s (Corps 1987).

Since the completion of WSD in 1983 geomorphic and riparian channel adjustments in Dry Creek have continued. Gordon (2004) found that the dam starved the Dry Creek channel of sediment, causing channel incision and entrenchment that allowed vegetation to colonize the less frequently flood prone banks and bars. Mean bed elevation lowered 1.02 meters from 1987-2003 at the Yoakim Bridge (Gordon 2004). Historical aerial photographs show that on Dry Creek, below WSD, the riparian vegetation has extensively encroached, causing the channel to narrow, and likely fostering channel incision. This incision has resulted in bank erosion and widening of the channel in the lower portion of Dry Creek (USACE and SCWA 2004).

3. Hydroelectric Operations

Hydroelectric production at the WSDHF and the LMHPP is achieved through flow releases from Lake Sonoma and Lake Mendocino respectively. The reservoir release rate is not based on the needs for power production, but rather is coincident to the releases to meet flood control and water demands. Hydroelectric operations at these facilities have not changed stream flow; therefore, the effects that have been associated with flow from flood control and power production in terms of minimum flow (D1610) and water demands would encompass the flow bypassed through the hydroelectric facilities for power production. WSDHF turbines can operate at flows between 70 and 185 cfs, but Article 33 of the FERC license requires that discharge from WSD meets the following minimum flow for normal, or above normal water supply conditions:

- May 1 through October 31 - 80 cfs
- November 1 through December 31 - 105 cfs
- January 1 through April 30 - 75 cfs

Article 15 of the FERC license allows for modifications of the project operation for purposes fish and wildlife conservation as may be ordered by FERC upon its own motion or upon the recommendations of fish and wildlife agencies after opportunity for hearing. The FERC license for the LMPP does not have flow requirements; therefore, power output is determined by flows released for water supply or flood control purposes. Power at this facility can be generated at flows ranging from 50 to 400 cfs.

4. Water Diversion Facilities

The operation and maintenance of the inflatable rubber dam at Mirabel and the Mirabel and Wohler diversion facilities has adverse effects on salmonid habitat and salmonids. Because SCWA proposes to continue operation and maintenance as part of the proposed project, these effects are described in detail in the *Effects of the Action* section and summarized here.

The rubber dam creates an impoundment which may delay salmonid adults, juveniles and smolts during their downstream migrations. Adult delays are anticipated to be minimal, while delay of juveniles is more pronounced. The impoundment inundates approximately three miles of stream habitat, further degrading habitat complexity. Inflation and deflation of the dam, as well as gravel bar grading at the dam site, may strand juvenile salmonids on dry areas of the channel bottom when flows recede. Gravel bar grading also

further degrades habitat complexity and adds small amounts of turbidity to aquatic habitat when flows first return to graded areas. Impounding water with the inflatable dam results in a small temperature increase in the already warm water in the impoundment. Dissolved oxygen is only minimally affected.

The diversion intakes may entrain some juvenile salmonids, harming or killing them. The off-channel diversion ponds can trap salmonids if the river flood flows enter the ponds. SCWA has rescued Chinook salmon and steelhead stranded in the ponds. In addition, SCWA rescues fish stranded during dam inflation/deflation. To date, no salmonids have needed rescue during dam inflation/deflation.

SCWA's uses chemicals to keep vegetation in check at their facilities, make diverted water potable, and control corrosion in pipelines. These chemicals may enter aquatic habitat, although in most cases the risk of chemical entry is low. SCWA has multiple best management practices in place to keep chemicals out of aquatic habitat and minimize accidental spills should they occur.

5. Channel Maintenance

Following completion of CVD in 1959, the Corps designated the SCWA and the MCRRFCD as local agencies responsible for channel maintenance in the main stem Russian River. SCWA and the MCRRFCD use USACE Operation and Maintenance (O&M) manuals to direct procedures for conducting channel maintenance at the Federal sites in Mendocino (36 stream miles) and Sonoma (22 stream miles) counties. Channel improvement sites include bank stabilization sites built to control stream bank erosion after CVD was constructed. Gravel bar grading and vegetation maintenance have also been conducted to prevent bank erosion along the main stem river.

Past channel maintenance actions have contributed to a decrease in salmonid spawning and rearing habitat suitability in the Russian River. The past effects of channel maintenance have likely affected salmonid populations by reducing pool habitat, high flow refuge, shade canopy, and cover utilized by various life stages of salmonids (Corps and SCWA 2004).

The Corps expected channel changes in the Dry Creek with the building of WSD, and constructed bank stabilization at 15 sites from 1981 to 1989 (Corps and SCWA 2004). In 1981 the Corps constructed three grouted rock-type grade control structures to prevent effects of constructing WSD. Other channel projects constructed by the Corps and currently maintained by the SCWA include riprap bank sites, and flow deflection fences, sediment removal, vegetation removal, and removal of debris.

The SCWA maintains 33.6 miles of flood control channels in zone 1A (CDFG 2006). These channels are significantly altered waterways that have been widened and straightened to increase hydraulic capacity. Maintenance activities in these channels have included sediment removal, channel debris clearing, vegetation maintenance, and bank stabilization. LWD was historically removed when it threatened to create a flow blockage or cause erosion. This activity has resulted in the removal of large quantities of woody debris.

Bank stabilization activities have typically involved the implementation of structures such as riprap. Both Santa Rosa Creek and Matanzas Creek stabilization projects have included substantial use of concrete and riprap, while most of the other channels are earthen with limited use of riprap (SCWA 1997). Currently, riprap is only used as needed. Planting of native riparian vegetation is now used as much as possible, and

in some locations, is the only means used to stabilize the banks (J. Niehaus, SCWA, personal communication, November 2006).

Natural waterways are streams that have not been modified for flood control purposes by the SCWA. Historically, regular maintenance was performed with the objective of maximizing the hydraulic capacity without enlarging the waterways. In the 1970s to 1980s, vegetation was removed from the bottom of the streams with the use of heavy equipment and hand crews with chainsaws. The use of heavy equipment ended in 1987, and clearing continued to be performed using hand labor. Between 1958 and 1983 some of the natural waterways were stabilized and straightened (Corps and SCWA 2001). LWD was historically removed annually and resulted in the removal of large quantities of woody debris and other potential habitat structures (SCWA 1997). Currently, maintenance is only performed on an as needed basis, usually to protect adjacent property (Corps and SCWA 2004).

6. SCWA Reservoirs

There are four flood control reservoirs in Zone 1A and one diversion structure: Santa Rosa Creek Reservoir (Spring Lake), Brush Creek, Piner Creek (on Paulin Creek), Matanzas Reservoir, and Spring Creek Diversion. The reservoirs are all located on Santa Rosa Creek or its tributaries. These reservoirs were built in the late 1960s to reduce flooding in the Santa Rosa area. Santa Rosa Creek Reservoir, also known as Spring Lake, is located offstream. A diversion structure at the inlet allows low flows to bypass the reservoir into Santa Rosa Creek and higher flows to enter the reservoir. A stand pipe allows water to flow back into Santa Rosa Creek when flows in the reservoir get too high. A fish ladder and vortex weir, built in 1962, are located on Santa Rosa Creek at the Spring Lake Diversion to allow anadromous fish passage (Corps and SCWA 2004). Brush, Piner, and Matanzas Creek reservoirs are all located instream and do not have fish ladders, therefore they are migration barriers that block habitat to potential spawning and rearing areas above the reservoirs. Also, these reservoirs may affect changes to the natural stream hydrographs and change sediment delivery patterns. Matanzas Creek has approximately 74 percent of its watershed above the reservoir. Brush and Piner Creek have a much smaller percentage of their watershed above their reservoirs compared to Matanzas Creek.

7. Estuary Breaching

Breaching of the bar has likely occurred at frequencies and timing similar to present day for the last 3-4 decades. While settlers in the 1800s may have breached the estuary during some years, there is little information on breaching frequency prior to 1968. In addition, little, if any, information is available on the frequency and duration of bar closure in the summer prior to the Potter Valley Project and the subsequent elevation of summer Russian River flows. Although D1610 set summer base flow requirements in 1986, these changes in summer flows may not have had a large impact on the frequency of breaching. Information for the years 1968 through 1974 (RREITF 1994) appears to indicate frequencies and timing of breaching mostly similar to current practices[40]. SCWA took over breaching from the Sonoma County of Public Works in 1995 (SCWA 2004b). Public Works had responsibility for estuary breaching as early as the 1950s (RREITF 1994).

[40] During 1968-1974, breaching occurred in the fall of 6-7 years and in the spring of 2 years. Comparisons among the breaching data from different time periods to ascertain impacts of different summer river flow levels need to be treated with caution. Differences in rainfall patterns may have occurred during the different sets of breaching data. These differences likely influenced breaching timing and frequency.

The potential for conversion to a freshwater lagoon after bar closure in the spring has likely been disrupted by breaching for many decades. As described in section V.A.2.d above, breaching keeps the estuary open to ocean tides, resulting in a marine environment near the mouth and extending upstream, depending on tidal fluctuations (SCWA 2004b). When the tide is in, marine or brackish[41] conditions extend further into the estuary. Rearing habitat for juvenile steelhead in the estuary often remains heavily influenced by the marine environment for months, limiting the amount of YOY and 1 + juvenile steelhead that can use the estuary due to their low salinity tolerance.

Every time the estuary is mechanically breached, much of the limited freshwater rearing habitat created by bar closure in the lower four miles of the estuary runs out into the ocean. The estuary becomes subject to ocean tides, and freshwater conditions fluctuate in this area while it remains open. Freshwater rearing habitat may only be maintained consistently near tributary mouths, where freshwater flows from tributaries maintain low salinity conditions in small areas of the estuary regardless of tidal action.

8. Artificial Propagation and Supplementation of Salmonids

Releasing large numbers of hatchery fish can pose a threat to wild salmon and steelhead stocks through genetic impacts, competition for food and other resources, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs are primarily caused by the straying of hatchery fish and the subsequent hybridization of hatchery and wild fish. Artificial propagation threatens the genetic integrity, and diversity that protects overall productivity against changes in environment (61 FR 56138). The potential adverse impacts of artificial propagation programs are well documented (Waples 1991; National Research Council 1995; National Research Council 1996).

Hatchery and out-of-basin salmonid stocks have been planted into the Russian River basin for over a century, primarily for population supplementation and fishing enhancement purposes. Relocation of rescued fish and excess spawning stock at DCFH has also occurred. Table 18 provides a summary of documented fish releases; however, it may not be inclusive of all plants. For the hatchery programs at DCFH/CVFF, it appears that imported stock was necessary to initiate a run back to the hatchery, and then later, to supplement insufficient numbers for broodstock purposes for the coho salmon and Chinook salmon hatchery programs. Wild fish were incorporated opportunistically into the broodstock as well.

Table 18. Stock sources and number of salmonids, by species, released into the Russian River basin between 1911 and 1998.

Coho Salmon			**Steelhead**			**Chinook Salmon**		
Stock Source	**Number**	**%**	**Stock Source**	**Number**	**%**	**Stock Source**	**Number**	**%**
Russian River	752,372	32.5	Russian River	18,167,885	54.3	Russian River	542,478	6.2

[41] Brackish water has salinity roughly in-between ocean salt water and freshwater.

Alsea River	58,794	2.5	Eel River	5,009,156	15.0	Eel River	218,257	2.5
Eel River	25,112	1.1	Mad River	324,101	1.0	Klamath River	1,000,000	11.4
Klamath River	451,370	19.5	Prairie Creek	249,000	.7	Mad River	9,250	.1
Noyo River	613,056	26.5	San Lorenzo Creek	83,350	.25	Sacramento River	3,283,295	37.6
Soos Creek	8,420	.4	Scott Creek	433,458	1.3	Silver King Creek	70,000	.8
Unknown	403,340	17.4	Unknown	8,934,122	26.7	Unknown	2,265,292	26.9
n/a	n/a	n/a	Washougal	270,360	.8	Wisconsin	1,337,624	15.3
Total	2,312,464	100.0	Total	33,471,432	100.0	Total	8,726,196	100.0

Sources: CDFG (1996, 1997, and 1998), SEC (1996), and Corps and SCWA (2000b).

Coho Salmon. The DCFH coho salmon mitigation and enhancement program began in 1980 using Iron Gate Hatchery coho salmon broodstock the first 2 years, followed by stocks from the Noyo River (1984-91), Iron Gate Hatchery (Klamath River, 1986-88), Prairie Creek/Redwood Creek (1987-88), and Hollow Tree Creek (Eel River, 1987 and 1990). The remaining years of program releases came from the progeny of coho salmon adults returning to the hatchery weir. Out-of-basin coho salmon stocks have been planted into the Russian River watershed, from the early 1930's through 1998 (FishPro and Entrix 2000). Coho salmon stock sources include Alsea River, Oregon (1972), and Soos Creek, Washington (1978); Noyo River coho salmon were also planted heavily in the Russian River from 1981 to 1996 (Good *et al.* 2005). Average annual releases of coho salmon from the hatchery decreased from just over 123,000 in the 1987-1991 period to about 66,000 in the years between 1992 and 1996. Noyo River broodstock continued to constitute about 30 percent of the releases during the latter period. Production at the facility was ceased entirely in 1996, after failing to meet mitigation goals. Adult coho salmon returns (minus jacks) to DCFH averaged 254 coho salmon between 1991 and 1996. Following the cessation of releases, no more than four coho salmon were trapped at DCFH in subsequent years.

As discussed above, DCFH received coho salmon from the Klamath and Eel rivers (FishPro and Entrix 2000), and also continued to receive transfers from the Noyo River system throughout its program. The effect of the Noyo River coho salmon stock[42] on current Russian River coho salmon populations was not evident in Hedgecock *et al.* (2002) research on coho salmon genetic population structure in California.

[42] The Noyo River stock is part of the same CCC Coho salmon ESU as the Russian River stock.

However, in their microsatellite analysis using a different data set of populations and year-classes, and a greater number of genes, Garza and Gilbert-Horvath (2003) found Noyo River influence within the Lagunitas/Olema coho salmon population.

Russian River Coho Salmon Captive Broodstock Program. In 2001, the RRCSCBP was initiated at DCFH with wild juvenile coho salmon to prevent extinction of coho salmon in the Russian River basin, and to reestablish self-sustaining runs of coho salmon in tributary streams within the Russian River basin. The immediate purpose of this program is to increase the abundance of the Russian River coho salmon population by supplementing the wild spawning population. This is being accomplished through conservation of the remaining native Russian River coho salmon genome through genetic management that uses a spawning matrix that optimizes the genetic diversity of the progeny of the captive broodstock and out-planting juveniles into streams for rearing under natural selection pressure. Since the program's inception, a cumulative total of 146,216 juvenile coho salmon have been released into the following tributaries of the Russian River: Palmer, Mill, Gray, Gilliam, Ward, Dutch Bill, Green Valley, and Sheephouse creeks (Table 19).

The 2006/07 return season was the first year that returning adult coho salmon were expected to return. Since low numbers of juvenile coho salmon were released in 2004, only very low numbers were expected to return to the three initial release streams. In order to assess adult returns to two of the release streams, spawning surveys were conducted in Mill and Sheephouse creeks. There were no adult coho salmon and no redds observed in Sheephouse Creek. In Mill Creek, one live adult unspawned female coho salmon was observed, and a week later the carcass was retrieved. Based on the coded-wire tag in the carcass, this adult coho salmon was confirmed to be a fish released into Mill Creek in 2004 (M. Obedzinski, U.C.Davis Extension, personal communication, 2007). The lack of rain events and resulting lower flows during much of the 2006/07 upstream migration season were poor for coho salmon migration. Low flows in late December and January may have affected the number of adult coho salmon returning to the release streams and may have contributed to adult coho straying to streams near the release streams. Adult coho salmon were not detected during spawning surveys during the 2007/08 spawning survey. However, a possible coho salmon redd was observed in Mill Creek during

Table 19. Russian River Coho Salmon Captive Broodstock Program: number of juvenile coho salmon stocked by release location and season of release for all four release years. Data from RRCSCBP, U.C.-Davis Extension.

	Release Year: 2004 Brood Year: 2003		**Release Year: 2005 Brood Year: 2004**		**Release Year: 2006 Brood Year: 2005**		**Release Year: 2007 Brood Year: 2006**	
Release Location	***Spring***	***Fall***	***Spring***	***Fall***	***Spring***	***Fall***	***Spring***	***Fall***
Sheephouse Creek	0	952	7,024	1,070	2,911	978	3,004	0
Mill Creek	0	3,433	0	4,399	5,297	6,302	8,038	25,154
Palmer Creek	0	0	2,466	1,920	2,102	3,021	3,967	3,880
Ward Creek	0	1,775	0	4,356	5,690	0	0	0
Gray Creek	0	0	2,584	2,240	3,201	3,772	2,995	5,584
Gilliam Creek	0	0	0	0	0	0	0	2,709
Dutch Bill Creek	0	0	0	0	0	5,286	0	7,945
Green Valley Creek	0	0	0	0	0	4,278	0	7,883
Seasonal Totals	0	*6,160*	*12,074*	*13,985*	*19,201*	*23,637*	18,004	53,155
Yearly Totals	*2004 Total: 6,160*		*2005 Total: 26,059*		*2006 Total: 42,838*		*2007 Total: 71,159*	

RRCSCBP Juvenile Release Total: 146,216

the spawning surveys in 2006/07, and two wild YOY coho salmon were captured in the downstream migrant trap on Mill Creek during the spring of 2007 (M. Obedzinski, U.C.Davis Extension, personal communication, 2007). These data suggest that at least three adult coho salmon from the RRCSCBP returned to Mill Creek during the 2006/07 spawning season, and that two may have successfully spawned. The YOY coho salmon are being held at DCFH as captive broodstock, and genetic samples were taken, however the samples have not yet been analyzed to determine if they are in-fact progeny of RRCSCBP released coho salmon or progeny of wild coho salmon. Additionally, recent downstream migrant trapping data has shown more than 500 wild coho YOY in Felta Creek as of May 2008 (J. L. Conrad, PSMFC, personal communication, May 21, 2008). These data suggest coho of either hatchery or wild origin successfully spawned within the Felta Creek watershed during the winter of 2008. Further genetic analysis will specify the origin of these YOY and will provide further information for refining the RRCSCBP.

Because of the extremely low returns of coho salmon to the Russian River and the likelihood of inbreeding and depensatory processes that will further diminish the river's coho population (see Section IV), the RRCSCBP is essential for the survival and recovery of the Russian River coho salmon population. The hatchery component of the RRCSCBP is funded annually by the Corps and implemented by CDFG. However, the continuation of the genetic management of the broodstock, and the follow-up field monitoring and evaluation components of the project are not currently funded by the Corps. As described in Section III.B.5, the Corps had proposed continuation of the RRCSCBP with continuation of

genetic management and field monitoring for program evaluation. Yet, the continuation of these primary components of the RRCSCBP is uncertain due to lack of short-term and long-term funding. The necessary genetic analyses and the annual development of the genetic spawning matrix were previously funded by NMFS and CDFG; however, that funding ran out after the 2007/08 spawning season. Without use of a genetic spawning matrix, inbreeding may further threaten the fitness and genetic diversity of coho salmon produced and released by the program. The monitoring and evaluation component of the program is currently funded by CDFG through the Fishery Restoration Grant Program; however, future funding for this component is uncertain. Without monitoring and evaluation, the success of the program will be difficult to assess and the program cannot be adjusted accurately if program efforts are not as successful as anticipated. The genetic management and the monitoring and evaluation components of the RRCSCBP ensure the program is accomplishing the goals of preventing extirpation of coho salmon in the Russian River basin and reestablishing self-sustaining runs of coho salmon in tributary streams within the Russian River.

Chinook Salmon. The stocking of Chinook salmon in the Russian River basin first occurred in 1892 and continued sporadically, until the 1950s and 1960s when efforts became more concerted (Myers *et al.* 1998; Chase *et al.* 2005). The Chinook salmon hatchery program at the DCFH was started with out-of-basin stocks (Eel River, Wisconsin strain (Green River, Washington) and Silver King Creek), in addition to Russian River returns. This hatchery program ceased in 1997 due to low adult returns (Good *et al.* 2005), that failed to meet mitigation goals. The Russian River has received fall Chinook salmon transfers from a number of sources, including West Coast hatcheries in other ESUs, Sacramento River stocks (1881, and 1950s-1960s), Trinity River Iron Gate Hatchery (1975), Eel River (1981-1993), Feather River (1982-1994), Wisconsin (1982-1986), Mad River (1983), and Nimbus Hatchery (1990-1994) (Meyers *et al.* 1998).. Natural production of these stocks has been identified as "native" (Myers *et al.* 1998).

The current run of Chinook salmon in the Russian River stems from natural production, and likely evolved as part of a diverse group of native coastal populations (Hedgecock 2002). Genetic analyses have indicated separation between Eel River, Russian River, and Central Valley Chinook salmon populations A history of hatchery stocking, however, has likely had some effect on genetic diversity (Bjorkstedt *et al.* 2006; Chase *et al.* 2007)

Steelhead. There has been a long history of hatchery and rescued fish plants into Russian River tributaries or underutilized habitat, dating back to before 1900 (Corps and SCWA 2004). In the early 1900s, steelhead from Scott Creek (Santa Cruz County), were released throughout the Russian River basin. Significant numbers of steelhead from the Mad River Hatchery (Humboldt County) were released into the Russian River basin prior to the construction of the hatchery. Other reported historical plant sources (FishPro and Entrix 2000) include: Eel River (1972), Prairie Creek (1927), Mad River/Eel River hybrids (1974), San Lorenzo Creek (1973), Scott Creek (1911), and Washougal River, Washington (1981). In 1970, 1,170 steelhead fingerlings were transferred during a fish rescue operation from Dutch Bill Creek into Atascadero Creek, tributary to Green Valley Creek; and another 30,800 fingerlings from DCFH were planted into Atascadero Creek in 1984 (CDFG 2000).

Adult steelhead returning to both facilities are historically in excess of the broodstock needs for the Steelhead Mitigation Program (FishPro and Entrix 2000). Beginning in the 2000/2001 spawning season, CDFG was directed by NMFS to spawn only marked fish at DCFH and CVFF. Beginning in 2004, adult

hatchery steelhead from both facilities are no longer relocated above natural barriers in the Russian River to avoid compromising the genetic integrity of isolated resident trout stocks (based on results from Deiner (2004) discussed below). Adult *wild* steelhead that return to DCFH are relocated into Dry Creek, and adult *wild* steelhead that return to CVFF are relocated to the West Branch Russian River above Mumford Dam. Adult *hatchery* steelhead that return to DCFH that are not needed for broodstock are released into the main stem Russian River, upstream of the confluence with Dry Creek. Adult *hatchery* steelhead that return to CVFF that are not needed for broodstock are relocated to the Ukiah and Cloverdale reach of the main stem Russian River, and to tributaries to the upper Russian River including: Ackerman, Feliz, Orrs, Gibson, Doolan, Mill (tributary to Forsythe), Hensley, McClure, McNab, Morrrison, Parsons, Howell, Dooley, McDowell, Twining, and Walker creeks.

Despite historical releases of out-of-basin steelhead, there appears to be a significant amount of population structure remaining among California coastal steelhead stocks. Garza *et al.* (2004) examined multi-locus genetic data from 62 populations of steelhead in coastal California DPSs, and concluded that the population structure of steelhead in coastal California has been influenced primarily by migration. In addition, drift and local adaptation likely contribute to the differentiation between all populations in the study. Results from both Garza *et al.* (2004) and Deiner *et al.* (2007) suggest that the steelhead populations within the Russian River have not been dramatically altered by hatchery releases. Recent genetic information on Russian River steelhead indicates that there are no substantial genetic differences between wild and hatchery propagated steelhead in the basin, indicating a moderate gene flow among below-barrier anadromous sites (Deiner 2004; Diener *et al*. 2007).

9. Monitoring of DCFH/CVFF Hatchery Operations

The RRCSCBP has a monitoring and evaluation component, guided by the program's Monitoring and Evaluation Subcommittee. Data collected through the monitoring and evaluation component are used to adaptively manage various aspects of the program. Downstream migrant trapping occurs seasonally on selected release streams in order to monitor the number and emigration timing of coho salmon juveniles released by the RRCSCBP. The RRCSCBP evaluations include oversummer and overwinter survival and growth, and comparisons of survival and fish size/condition between spring and fall coho salmon releases. Incidental information is also collected on the number of emigrating steelhead smolts, species and size data on lamprey (*Lampetra* spp.) and counts of all other captured fish species. Tissue samples are taken from coho salmon and steelhead for genetic analysis. The RRCSCBP also monitors water flow, water temperature, and food availability of benthic macroinvertebrates in many of the release streams. Adult spawner surveys and adult trapping is also conducted in several of the release streams.

The CDFG has conducted habitat and biological surveys throughout the Russian River basin to gather information for habitat assessments, including a recent inventory on presence/absence of coho salmon. CDFG habitat assessments have provided guidance for choosing fish planting locations for the RRCSCBP.

Trout Unlimited, in cooperation with the SCWA and NMFS, is attempting to quantify the abundance of steelhead smolts produced by the Austin Creek watershed within the Russian River basin (Katz *et al.* 2006). Monitoring objectives include estimation of coho salmon, Chinook salmon, and steelhead smolt abundance, migration timing, and characterization of other demographics for these species. Fish are trapped by a rotary-screw trap, and counts are expanded from mark recaptures.

10. Main stem Russian River Channelization

Bank stabilization of the Russian River to secure property lines began as early as 1850. In the 1930s the Corps constructed levees along the riverbanks in the Cloverdale area to address flooding concerns. In the 1950s farmers commonly dumped brush, old tires, and wrecked car bodies into the river in an attempt to stabilize the banks in the Ukiah area (Chocholak 1992). These practices may have continued into the later part of the 20th Century.

To minimize anticipated changes in channel morphology following construction of CVD, the Corps constructed several channelization and stream bank stabilization projects along the main stem Russian River from 1956 through 1963 (Corps 1997). Project work included channel clearing, creation of pilot channels, bank protection works consisting of anchored steel jacks, flexible fence structures, wire mesh revetments, and impervious erosion check dams. These channel structures were located at 41 sites in Sonoma County in the Alexander Valley, and along a 15 mile reach of the Russian River in Mendocino County (Corps 1997).

Construction of levees has constrained the flows of the Russian River to a narrow channel. This has increased flood velocities and decreased sinuosity, causing channel degradation and loss of channel form diversity and habitat in the Russian River. Levees effectively remove the channel/floodplain interaction, destroying riparian cover and crucial low flow, back-channel habitat.

11. Agriculture

Agricultural activities have significantly altered the riparian and aquatic habitat in the Russian River watershed. Circuit Riders Productions, Inc. (2001) summarized the changes in the riparian corridor along the alluvial reaches of Mendocino County, and reaches of Alexander Valley, and the Middle Reach. Between 1940 and 2000, the Alexander Valley lost 41 percent and the Middle Reach lost 36 percent of the riparian vegetation along the river (Circuit Rider Productions 2001). During the same time period, Circuit Riders Productions (2001) reports that the loss of riparian vegetation in Mendocino County was 31 percent. By 1990, 92 percent of the riparian area of the Laguna de Santa Rosa was gone (David W. Smith Consulting 1990). In addition to these losses in native vegetation, there has been a substantial effect on the main stem Russian River from introduced species such as the giant reed (*Arundo donax*). This invasive plant is particularly troublesome because it suppresses the germination of seedlings, including native riparian species (Circuit Riders Productions 2001).

Much of the recent loss in riparian vegetation along the Russian River is due to its conversion to agricultural production, most recently vineyards. Vineyard development is believed to be increasing along the main stem Russian River and throughout the watershed in both Mendocino and Sonoma counties. For example, in Sonoma County, there are 56,000 acres of vineyard, with more than 13,000 acres planted in the late 1990s; a thirty percent increase (Chorneau 2001). This expansion has intensified pressure to encroach on riparian vegetation and, perhaps more significantly, has increased soil disturbance and erosion. The potential for erosion increases particularly as vineyards expand out of the valley floors and onto hill slopes (Dahlgren *et al*. 2001). Other common streamside activities related to agriculture are stream channelization and streambank stabilization.

Water diversions needed for agriculture have altered flow regimes in the Russian River and its tributaries. In addition to the two large reservoirs in the basin, numerous permanent and temporary water withdrawal facilities divert water and impede fish passage. The State Water Resources Control Board estimated 1,281 existing and unauthorized dams within Mendocino and Sonoma Counties holding back an estimated 29,663 acre-feet of water (Stetson Engineers 2007). The cumulative effects caused by dams and water diversions have likely led to the decline of salmonids within the Russian River. Impacts from water withdrawals and dams include localized dewatering of streams, migration barriers for multiple salmonid life stages, and depleted flows necessary for migration, spawning and rearing.

12. Urban Development

The majority of the human population in both Sonoma and Mendocino counties lives in the Russian River watershed, and profoundly affects salmonids and their habitats throughout the watershed. Construction of buildings, sidewalks, parking lots, and roads lead to an increase in the amount of impervious surfaces in the watershed. Impervious surfaces have dramatic affects on stream hydrology (reviewed in Calder 1993, Urbonas and Roesner 1993, and Brabec *et al*. 2002). Impervious surfaces prevent water from soaking into the ground. The volume and velocity of stormwater runoff is directly proportional to the amount of impervious surfaces. Increased stormwater volume and velocity cause increased stream bank erosion, sedimentation, and increased flooding (Florsheim and Goodwin 1993).

Urbanization also adds constraints to the stream channels such as roads, culverts, grade control structures, and bridges (Florsheim and Goodwin 1993). These constraints often create barriers to fish migration and unstable stream banks. Frequently, urbanization development leads to additional flood control measures when low-lying agricultural or natural areas are converted to urban uses (Florsheim and Goodwin 1993). Over the past few decades, the conversion of agricultural land to urban uses has occurred throughout much of the Russian River farming area, but is most common in the Zone 1A cities of Windsor, Santa Rosa, and Rohnert Park.

13. Instream Road Crossings

To provide access across streams during the dry season, there are at least five temporary gravel road crossings of the Russian River currently used: one near Asti (Washington School Road), three near Guerneville (Odd Fellows Road, Guernewood Park, and Vacation Beach), and one near the Dry Creek/Russian River confluence (Syar Industries crossing.) There are probably several other sites on the Russian River or its tributaries where vehicles simply ford the stream.

Although there is some overlap of late-emigrating juvenile salmonids or adult Chinook salmon migration timing, each of these five larger instream road crossings allow for surface stream flow. CDFG biologists report that summer road crossings have little or no effect on fish passage (CDFG 1991). Some direct effects to salmonids are expected with the construction and demolition of the instream road crossings. Some habitat is lost when the gravel roadbed is placed in the stream. Also, turbidity increases dramatically during both placement and removal of the gravel roadbed.

14. Small Dams

In addition to the WSD, CVD, and the SCWA's inflatable dam at Mirabel, there are numerous small dams within the Russian River watershed. Many of the reservoirs formed by these small dams are enduring, while many others are seasonal. These small dams are used to provide water supply (urban or agricultural), recreational use, or grade control, and some dams are derelict with no known purpose. Placement of various dams in the Russian River has occurred for more than 130 years.[43]

The permanent Willow County Water Diversion Dam spans the Russian River at RM 88 near Ukiah. The dam was formed by piling rocks and recycled concrete pieces across the channel, then covering that material with concrete. Fish passage parameters at this dam are unknown; however, given that no fish passage structures were incorporated during the construction of this dam, it is likely that this dam reduces passage opportunities for salmonids during some flows. Both Winzler and Kelly (1978) and CDFG (1991) conclude that this dam may negatively affect fish passage. Examples of other permanent dams within the watershed include a concrete grade control structure on Windsor Creek about 1 km upstream of Highway 101 and a derelict concrete dam of unknown purpose on Santa Rosa Creek near the intersection of Los Alamos Road and Melita Road; there are no fish passage structures at either of these dams.

There are three large seasonal dams routinely installed in the main stem Russian River during the summer to enhance recreation. Vacation Beach Dam is located at RM 12 and has a permanent 8-foot-tall concrete base with collapsible steel support beams for wooden flashboards. Johnson's Beach Dam is located at RM 14 and has an 8-foot-tall permanent concrete and steel pier structure with removable flashboards. Healdsburg War Memorial Beach Dam is located at RM 32 and is a 16.5-foot-tall concrete sill structure with removable flashboards and steel support beams. All of these summer recreational dams have fish ladders. The Vacation Beach Dam and Johnson's Beach Dam do not affect fish passage when the flashboards are not installed. The fish ladder at the Healdsburg War Memorial Beach Dam does not function when the flashboards are in use during the summer months. A fourth large seasonal dam, Del Rio Woods Dam, operated by the Del Rio Woods Recreation and Park District at RM 35, has not been installed since 2001.

The large recreational dams on the main stem Russian River will be installed on June 15th or later and removed by October 1st. This timing is outside of the anticipated migration of adult coho salmon and steelhead (Fukushima and Lesh 1998). Adult Chinook salmon may begin migrating in the Russian River as early as August, if conditions are appropriate, though the majority of adult Chinook salmon in the Russian River migrate October through December (Fukushima and Lesh 1998; Chase *et al*. 2005). Although there is some overlap of adult Chinook salmon migration timing, each of these large recreational dams has a fish ladder in place. Based on the results of video monitoring from 2000 through 2004, Chinook salmon appear to be successful in finding and ascending the fish ladders past the Mirabel Dam (Chase *et al*. 2004). Beyond the video monitoring, SCWA staff has conducted snorkel surveys near the entrances to the Mirabel Dam fish ladders and have not noted large numbers of adult Chinook salmon milling about at the fish ladder entrances. The large recreational dams are operated to avoid the majority of the emigration of salmonid smolts, though some smolts may still be emigrating from the Russian River though June (Fukushima and Lesh 1998). The small number of late-emigrating smolts may be delayed at the large recreational dams, but the delays are likely of short duration (Chase *et al*. 2004). The smaller

[43] August 12, 1869, edition of the *Russian River Flag*. Reference not seen – a purported excerpt was found at www.ourhealdsburg.com/history/transportation.htm

summer dams on the tributaries of the Russian River may preclude or delay migration of juvenile salmonids in summer (NMFS 2001).

15. Gravel Extraction

Gravel mining, along with reductions in sediment supply caused by CVD, and channelization efforts have resulted in bed elevation decreases in the main stem Russian River in Mendocino County. This bed lowering, or incision in the Ukiah Valley reach of the Russian River has reduced the elevation of the river's thalweg by 18 ft in some areas. This incision of the mainstem has in turn caused incision of tributary streams. Current channel conditions reported by Halligan (2004) indicate that the incised upper main stem channel has remained relatively stable in terms of elevation with little degradation or aggregation of the thalweg from 1996 to 2002. Peak flows observed by NMFS staff in December of 2006 caused some degradation in the upper main stem Russian River resulting in approximately two feet of downcutting along this reach.

Excessive extraction of instream gravels in Sonoma County has impacted three mining areas that include the Alexander Valley, and the Middle Reach. The Alexander reach, which is approximately 16 miles long, has experienced channel incision of up to 12 ft near the Geyserville Bridge (Florsheim and Goodwin 1993). The channel sinuosity in this reach has decreased due to instream mining, channelization, and agricultural activities.

The most current information for the Middle Reach indicates that replenishment of gravel exceeds extraction. County regulations, such as the Sonoma County Aggregate Resources Management Plan, and the Mendocino County Aggregate Resources Management Plan attempt to maintain extraction rates below annual replenishment rates. These regulations appear to be successful with a Middle Reach sediment recharge rate averaging 430,800 tons, and 183,000 tons proposed for harvest in this area of the Russian River (Entrix 2006).

Gravel extraction in the main stem Russian River has impacted salmonid habitat over time by altering the channel's natural geomorphology. Channel incision creates migration barriers at the mouths of tributaries and lowers the water table which in turn affects perennial stream flow. Impacts to spawning habitat are due to changes in sediment transport, and gravel quality that reduce the overall spawning habitat quality for salmonids attempting to utilize main stem habitat. Effects to riparian vegetation, pools and riffle sequences and gravel quality from gravel extraction limit rearing opportunities for juvenile salmonids. Large scale extraction of gravel is not expected to occur in the future with the current gravel management plan that exists in Sonoma County. Current gravel extraction practices are much improved with most operators following NMFS (2004) sediment removal guidelines which minimize impacts to salmonid habitat at a localized level. Improvements in gravel extraction methods in specific reaches of the main stem Russian River are likely to minimize effects to spawning habitat, and rearing habitat such as pool and riffle frequency, and riparian vegetation in the future.

16. Timber Harvest

Current timber harvest activities are conducted on a much smaller scale and are subject to California Department of Forestry regulations. The current trend is to convert timberland into vineyards, with significant increases in both Sonoma and Mendocino counties since 1990 (UC Hopland 2002). Between

1990 and 1997, 1,631 acres of dense hardwood forest, 278 acres of coniferous forest, 367 acres of shrubland, and 7,229 acres of oak grassland savanna were converted to vineyards in Sonoma County (Merenlender 2000). In Mendocino County there have also been a significant number of acres of native vegetation converted to vineyard acreage (UC Hopland 2000).

Past timber harvest actions are responsible for increasing sediment loads to streams by using streambeds for roads, increasing erosion from hillsides and stream banks. Increased delivery of sediment to streams is known to reduce spawning and rearing habitat quality, which may persist for many decades. Reductions in riparian forests associated with early timber harvest likely increased stream temperatures, reduced inputs of allochthonous and woody debris causing impacts to stream habitat quantity and quality.

The level of impact that timber harvest may have caused in the main stem Russian River is unclear. Transport of fine sediment and elevated water temperatures to the main stem channel likely had some impact on the Russian River in the past. Current timberland activities that impact the main stem Russian River are likely associated with localized harvest and the conversion of timberlands to vineyard production that can increase sediment transport and impact riparian areas in tributaries of the Russian River.

17. Fisheries Management

Angling regulations permit the daily harvest of two hatchery trout or two hatchery steelhead, in the Russian River main stem below the confluence of the East Branch Russian River all year. Only artificial lures with barbless hooks may be used from April 1 through October 31, and only barbless hooks may be used from November 1 through March 31. The main stem Russian River above the confluence of the East Branch Russian River and all other tributaries, and the area within 250 feet of the Healdsburg Memorial Dam, are closed to fishing all year (CDFG 2006). Santa Rosa Creek and Laguna de Santa Rosa, Sonoma County tributaries to the Russian River, have a summer catch-and-release fishery (Good *et al.* 2005). There is no legal harvest of coho salmon within the CCC coho salmon ESU; any coho salmon mortality due to angling would be due to incidental catch-and-release hooking mortality in other fisheries, accidental harvest related to errors in identification, or poaching. The CDFG Steelhead Fishing Report-Restoration Card has been in place since 1993, and has collected angling information to estimate harvest and releases of wild and hatchery steelhead throughout the state, since 1999. The most recent trout angling data from the Russian River reflects an increasing state-wide trend of re-releasing caught hatchery steelhead, complicating fishery management for the conservation of natural steelhead stocks (T. Jackson, CDFG, personal communication, January 24, 2007).

Hopkirk and Northen (1980) briefly describe some of the “rough fish” control measures undertaken in the Russian River watershed in the 1950s and 1960s. “Rough fish” is a term used to cluster non-exploited fish, and generally includes minnows, suckers, sculpins, and other less common groups not targeted by anglers. To minimize competition between game fish and rough fish, the CDFG applied rotenone, a potent ichthyocide, several times to the Russian River and to 118 miles of ten tributaries in the Upper Russian River watershed, Dry Creek watershed, and Zone 1A. Hopkirk and Northen (1980) do not describe any measures taken to protect salmonids during the rotenone applications, though certainly some must have been taken or they would have been killed with the rough fish. The rotenone treatments were largely ineffective at controlling rough fish populations, as within a couple years, the abundance of rough fish returned to pretreatment levels.

18. Water Diversions

Water diversion actions occur along most of the main stem Russian River and Dry Creek. Most diversions are associated with frost protection, heat control, or irrigation of vineyards or pear orchards. Most of the diversion facilities are equipped with self cleaning screens that meet NMFS screen criteria for protection against impingement and entrainment of salmonid fry (J. Bennet, Natural Resources Conservation Services, personal communication, April 2007).

Wells and other diversions have reduced available wetted habitat in some of the Zone 1A tributaries. Most of these Zone 1A diversions have occurred in rural upper Mark West Creek. A juvenile salmonid density monitoring study was conducted in the years 1993-2002 by Merritt Smith Consulting in a few Russian River tributaries. Summer diversion activities were found to contribute to the loss of rearing habitat in some areas.

19. Restoration Actions

Many instream and near-stream restoration activities have occurred throughout the Russian River watershed. Many of these activities were undertaken specifically to improve aquatic and riparian habitat to benefit salmonids. Examples of recent restoration activities include: 1) stabilizing stream banks, slides, roads, and gullies; 2) placing weirs and log structures in streams; 3) replaced instream road crossings and undersized culverts with appropriately sized culverts or bridges; 4) contoured stream banks to recreate or rehabilitate flood plains; 5) replacing riprap or other hardened surfaces using bioengineered techniques; 6) removing and replacing nonnative vegetation with native vegetation; 7) installing grazing excluders; and 8) improving fish passage at dams, such as the Healdsburg War Memorial Dam or Mumford Dam. These restorations projects were undertaken by the SCWA, or private landowners to fix chronic watershed problems that were degrading valuable habitat. Restoration objectives included: reduce erosion and minimize sediment delivery to streams, stabilize stream bed and grade, provide access to spawning and rearing habitat upstream by eliminating passage barriers, improve stream/floodplain connectivity, and provide cover and lower stream temperatures.

Nearly all instream and near stream restoration activities have environmental costs associated with their construction. Impacts included capture and relocation of fish, turbidity, or loss of riparian vegetation. However, those effects were generally small, localized, and of short duration. Long-term habitat impacts have been beneficial as salmonids have access to more spawning and rearing habitat, thereby facilitating recovery of salmonid populations. Also, restoration of hydrologic, geomorphic and sediment processes will lead to floodwater retention and water quality improvement further improving the value of salmonid habitat in the Russian River watershed. These changes are expected to improve spawning, rearing, or migration success of Russian River salmonids in future years.

20. Natural Events

Natural events such as droughts, landslides, floods, and other catastrophes have adversely affected steelhead and salmon populations throughout their evolutionary history. The effects of these events are now often exacerbated by anthropogenic changes to watersheds such as logging, road building, and water

diversion. These anthropogenic changes have limited the ability of these species to rebound from natural stochastic events and depressed populations to critically low levels.

Variability in ocean productivity has been shown to affect salmon production both positively and negatively. Beamish and Bouillion (1993) showed a strong correlation between North Pacific salmon production from 1925 to 1989 and their marine environment. Beamish *et al*. (1997) noted decadal-scale changes in the production of Fraser River sockeye salmon that they attributed to changes in the productivity of the marine environment. They (along with many others) also reported the dramatic change in marine conditions occurring in 1976/77, at the beginning of an El Niño event. El Niño conditions, which occur every 3 to 5 years, negatively affect ocean productivity. Johnson (1988) noted increased adult mortality and decreased average size for Oregon's Chinook and coho salmon during the strong 1982/83 El Niño. Although scientific understanding of the precise extent that ocean conditions have contributed to salmonid declines is limited, ocean conditions have likely affected populations throughout their evolutionary history.

Reduced marine derived nutrient (MDN) transport to watersheds is another consequence of the past century of decline in salmon abundance (Gresh *et al*. 2000). Salmon may play a critical role in the survival of their own species in that MDN (from adult salmon carcasses) has been shown to be vital for the growth of juvenile salmonids (Bilby *et al*. 1996, Bilby *et al*. 1998). The return of salmon to rivers makes a significant contribution to the flora and fauna of both terrestrial and riverine ecosystems (Gresh *et al*. 2000). Evidence of the role of MDN and energy in ecosystems infers this deficit may indicate an ecosystem failure that has contributed to the downward spiral of salmonid abundance (Bilby *et al*. 1996).

As described above in the ***Status of the Species and Critical Habitat*** section, the most relevant trend in global climate change is the warming of the atmosphere from increased greenhouse gas emissions. Global warming is likely to manifest itself differently in different regions. Impacts identified above for California include increase in the number of critically dry years (Cayan *et al.* 2006). Many of the threats already identified for these salmonid populations are related to a reduction in surface flow of tributary streams. Future climate change may therefore substantially increase risk to the species by exacerbating dry conditions. It is possible, but unlikely, that global climate change could affect the ability of SCWA and the Corps to operate the project for the next fifteen years as proposed: in a manner that mimics the previous fifteen years. NMFS does not expect that dramatic local impacts from global climate change will be realized within the next fifteen years. Progress is being made on forecasting decadal changes of surface temperature due to global climate change on global and large regional scales (Smith *et al*. 2007). However, predicting impacts on more local geographic areas remains elusive.

Marine mammal predation is not believed to be a major factor contributing to the decline of West Coast salmon and steelhead populations relative to the effects of fishing, habitat degradation, and hatchery practices. Predation may have substantial impacts in localized areas. Harbor seal (*Phoca vitulina*) and California sea lion (*Zalophus californianus*) numbers have increased along the Pacific Coast (NMFS 1999a). However, at the mouth of the Russian River, Hanson (1993) reported that the foraging behavior of California sea lions and harbor seals with respect to anadromous salmonids was minimal. Hanson (1993) also stated that predation on salmonids appeared to be coincidental with the salmonid migrations rather than dependent upon them.

VI. EFFECTS OF THE PROPOSED ACTION

We approached the effects analysis by first identifying the salmonid habitats, including PCEs of critical habitat, likely to be adversely affected by the proposed project. We then overlaid the analysis of effects to habitat onto an analysis of the effects to individual salmonids, 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. We have organized the analysis around major project elements (flood control operations, channel maintenance, *etc*.).

In our effects analysis, we have used data and/or modeling efforts specific to the Russian River and the action area when such information is available. For example, in analyzing the impacts of D1610 stream flows on critical habitat and listed salmonids in Dry Creek and the main stem Russian River, we used the results of a 2001 flow-habitat assessment study conducted in these areas. Where data specific to the Russian River watershed and/or action area are unavailable, we have utilized information from other nearby river systems and more general information regarding aquatic habitat and salmonid responses to environmental perturbations. This information was then overlaid with the proposed project to produce reasoned conclusions regarding likely effects of the project on critical habitat and listed salmonids in the action area when added to the baseline.

The information described in this section (**VI. *Effects of the Proposed Action***) is used later in section **VIII. Integration and Synthesis.** That latter section assesses the ramifications of the effects of the proposed project in the action area on the role and function of critical habitat for species conservation and the likelihood of the survival and recovery of the species at the ESU or DPS scale.

A. Flood Control - Coyote Valley Dam Operations

1. Impacts to Habitat, Including Critical Habitat, in the Mainstem Russian River

CVD flood operations include both water storage and water releases. Water storage reduces the magnitude of flood peaks, while flood releases have the potential to scour the streambed, erode banks, increase turbidity, and may create dewatered channel conditions during ramp downs of flood releases. NMFS' analysis found adverse impacts to Chinook salmon spawning habitat from scour and bank erosion, and potential impacts to Chinook and steelhead spawning and rearing habitat from the release of turbid waters. Ramping of flows was found 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. Pre-flood and periodic inspections during the fall (September) are likely to cause dewatered channel conditions, adversely affecting rearing habitat for juvenile steelhead, as described below.

a. Streambed Scour

CVD flood control operations are designed to reduce the magnitude of flood peaks in the mainstem Russian River downstream of the confluence with the East Branch. Even though the CVD flood operations mute the peak flows, the magnitude of some flood releases from CVD may be sufficient to cause streambed scour that can adversely affect salmonid redd areas. To analyze the potential for streambed scour to affect salmonid spawning gravels in the mainstem Russian River, we evaluated an assessment by the Corps and SCWA (2000a), and our own field surveys of scour in the Russian River

main stem[44] downstream of the CVD. NMFS also reviewed CVD flow releases and mainstem Russian River flows that influence this area of the Russian River mainstem, and redd scour studies conducted on the Trinity River that evaluated flood operation releases below Lewiston Dam.

Channel forming flows, the dominant discharge known to mobilize the streambed, occur every one to two years (Kondolf and Williams 1999). In the Russian River near Ukiah the dominant discharge flow is estimated to be 4,200 cfs (Florsheim and Goodwin 1993). Further downstream at Hopland such flows are in the vicinity of 9,500 cfs (Corps and SCWA 2004). We reviewed hydrologic data and CVD flood release data to determine if CVD flood releases alone or in combination with main stem flows increase the frequency or duration of channel forming flows that may mobilize the streambed and affect salmonid redd sites in the mainstem Russian River downstream of CVD. To do this, we used the mean daily flows in the Russian River gauged directly above the confluence with the East Branch as a surrogate for flows occurring downstream of the confluence for approximately five miles. This location, the Ukiah Reach, is a major Chinook salmon and steelhead spawning area. Our comparison focused on whether CVD releases resulted in channel forming flows in the Ukiah Reach that would not have occurred due to flows entering this reach from the Russian River mainstem directly above the confluence with the East Branch.

This analytical approach ignores pre-dam conditions and the amount of flows coming from the East Branch in a "pristine" environmental setting (pre CVD and Potter Valley). While such information may be helpful in determining impacts at the population and ESU or DPS scale, it is not appropriate for the exposure and response analysis we report here. The Corps controls how flood releases occur at CVD, and critical habitat and salmonids are exposed to the results of those releases, regardless of historical conditions and what they may have experienced in a "pristine" environment.

Our results indicate in years when channel forming flows occur in the Ukiah Reach, the duration of these flows can be increased from December through March by CVD flood releases as shown in Table 20. Channel forming flows in this reach of the mainstem would have receded earlier had CVD releases not been made, or been made differently. During large storm events when the main stem Russian River reaches channel forming flows, CVD is releasing very low flow to minimize flooding in Ukiah and Hopland. Once the main stem flows begin to recede, CVD releases water that has been stored during winter storm events. These post storm flood releases of 1,000 to 6,400 cfs can by themselves or in combination with main stem flows reach or exceed channel forming discharges. CVD's extension of channel forming flows typically occurs in wet years. Longer durations of channel forming flows, such as occurred in 1998 and 2006, likely increase the potential for streambed scour during these events. However, CVD also reduces the magnitude of very large storms (those that raise Russian River flows far above channel forming thresholds), likely reducing the scour potential of those events.

Due to the paucity of site specific data for this area of the Russian River we used May *et al*. (2007) to gain understanding of the relationship among river discharge, bed mobility, and scour depths in areas used by spawning salmonids. May *et al*. (2007) 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.

[44] As described in the Environmental Baseline, no spawning habitat exists in the East Branch of the Russian River due to the CVD.

Given the streambed scour evaluation on the Trinity River, and that CVD increases the duration of channel forming discharges from December through March, we conclude that winter flood operations are likely to contribute to scour of salmonid spawning gravels during this time period. Because Chinook salmon spawn, and their eggs incubate during this time, the PCE of Chinook spawning habitat is likely to be adversely affected. Some steelhead spawning habitat may also be adversely affected. However, most steelhead use spawning gravels later in the year, when scour from flood operations is much less likely to occur.

Recent studies suggest that Chinook salmon are well adapted for reproductive success in flood prone river systems. May (2007) found that site selection preferences by Chinook salmon correspond to areas of the streambed that are least likely to become mobilized or be at risk for deep scour. Several studies cited by May *et al*. (2007) found that the average probability of Chinook salmon redd scour, defined as net scour greater than 30 cm in riffles, ranged from as little as 5 percent during annual floods to 20 percent for extreme, multi-century recurrence floods. For the Trinity River, May *et al*. (2007) found the probability of scour (>23 cm of depth) for Chinook salmon eggs is about seven percent when the streambed is fully mobile. Baseline channel conditions in the upper Russian River likely increase the potential for streambed scour in the upper Russian River during 1.5 to 2 year flood events. Channel incision, dense mature riparian vegetation, and the lack of complexity in the form of LWD or other roughness elements help to concentrate shear stress on the channel's streambed. Present channel conditions are likely to increase the potential for streambed scour due to the uniform distribution of shear stress along the channel bottom. Therefore, we expect that increased duration of channel forming flows caused by CVD are likely to cause slightly higher scour in riffles used by Chinook salmon for spawning than the five percent reported above for annual storm events. We estimate that scour of these riffles in the main stem below CVD may approach 10 percent. Scour as defined above diminishes the function of these areas as spawning PCEs until additional gravel is deposited during subsequent storms.

Table 20. Number of days CVD operations increase the duration of flows > 4,200 cfs in the Russian River mainstem below the confluence of the East Branch. The number of storms where CVD increased the duration of these flows is also shown.

Water Year	Number of Days flows in Ukiah Reach > 4,200 cfs without CVD	Number of Days CVD Extended the Duration of Flows in Ukiah Reach Over 4,200 cfs	Number of Storm Events CVD Extended the Duration of Flows Over 4,200 cfs
1994	None	None	None
1995	5	3	2
1996	None	2	2
1997	3	1	1
1998	1	14	5
1999	None	None	None
2000	None	1	1
2001	None	None	None
2002	None	None	None
2003	None	1	1
2004	1	2	2
2005	None	None	None
2006	3	8	2
2007	None	None	None
2008	1	None	None

b. Bank Erosion

CVD flood release flows of up to 6,400 cfs are likely to contribute flows that would initiate bank erosion along the main stem Russian River. Flows of 6,000 cfs or greater are needed to initiate bank erosion along the upper Russian River down to Hopland (Corps and SCWA 2004). When Russian River flows are elevated during storm events, CVD outflow is usually low, but during some winters with high rainfall, the CVD flood release contribution to flows at Hopland extends the duration of flows that can cause bank erosion. NMFS evaluated hydrologic data from CVD and for the Russian River, and found that CVD flood releases of 1,000 cfs and larger can, when added to mainstem flows, reach the bank erosion threshold of 6,000 cfs at Hopland. The additional duration of flows over the bank erosion threshold attributable to CVD releases is shown in Table 21.

CVD flood releases and storage operations are expected to result in small amounts of bank erosion. Large bank failures resulting from CVD releases are not expected because channel adjustments have occurred since the construction and operation of CVD. Bank erosion from CVD flood releases is expected to be minimal with input of sediment and riparian vegetation at few sites along the mainstem when bank erosion occurs.

Bank erosion contributed by CVD operations will likely reduce spawning habitat quality directly downstream of the bank erosion sites. Inputs of riparian vegetation are likely to increase the channel complexity for juvenile salmonids, yet will also reduce other parameters such as shade canopy. Some localized reduction in spawning habitat quality and spawning success is likely from the input of sand sized bank material to the streambed.

c. Flow Changes, Intermittent flows and Dewatering

As described in the Project Description, CVD operations incrementally ramp flows to accomplish flood control or release water supply to meet downstream flow requirements of D1610. Flow ramping rates for releases of 1,000 cfs or lower were modified in 1998 to minimize effects to listed salmonids in the Russian River. The USACE proposes to continue to use the interim ramping rates of 250 cfs/hr when flows are between 250 and 1,000 cfs, and 25 cfs/hr when flows are less than 250 cfs. When CVD releases flows of 1,000 cfs or greater the ramping rates are limited to not more than 1,000 cfs on the ramp down, and not more than 2,000 cfs when ramping up.

Flow ramping can cause intermittent surface flow, and at times may completely dewater portions of streams (Hunter 1992). Intermittent and dewatered areas are likely to be found in rivers with many side channels, potholes, and low gradient bars. Conversely, confined channels with steep banks have less potential for dewatered and intermittent areas.

CVD flow ramping impacts are likely to be most pronounced in the four mile stream segment below the confluence of the East Branch Russian River and main stem. In this reach, dewatered areas are most likely to occur in the spring when ramp down at 1,000 cfs per hour is conducted in conjunction with naturally receding flows. This reach has low gradient gravel bars with cobble substrates and backwater pools that are likely to become disconnected from the main channel and/or dewatered during ramping (Corps and SCWA 2004). The Corps and SCWA (2004) note that elevated storm runoff from the upper main stem may dampen this effect during late winter and spring, but that under some flow conditions, CVD ramp down of 1,000 cfs per hour may cause bar areas or off channel pools to become dewatered or disconnected from the main river channel from January through May.

Table 21. Number of days CVD operations increase the duration of flows > 6,000 cfs at Hopland. The number of storms where CVD increased the duration of these flows is also shown.

Water Year	# of Days > 6,000 cfs at Hopland without CVD	# of Days CVD Extended the Duration of Flows > 6,000 cfs at Hopland	# of Storm Events CVD Extended the Duration of Flows > 6,000 cfs
1994	None	None	None
1995	13	2	2
1996	2	2	2
1997	5	None	None
1998	10	16	5
1999	2	None	None
2000	1	None	None
2001	None	None	None
2002	1	None	None
2003	8	1	1
2004	7	4	3
2005	1	None	None
2006	9	6	3
2007	None	None	None
2008	3	None	None

Surveys of the East Branch Russian River and upper main stem Russian River by NMFS and USACE staff have determined that the potential for intermittent and dewatered areas in the East Branch is low due this segment's steep banks and lack of side-channels. These areas are only dewatered when flow is entirely stopped at the dam. Such conditions only occur during annual pre-flood and five-year periodic inspections.

Pre-flood and five-year periodic inspections are likely to have a more pronounced effect on the East Branch than the main stem because flow is stopped in a portion of the East Branch. As described in the *Project Description*, the Corps will reduce or shut-off stream flow from CVD to conduct inspection activities. Annual pre-flood and five-year periodic inspections will be conducted during the fall, usually in September to ensure CVD flood control facilities are operational for the upcoming winter storm season. The ramp down and complete shut-off of water from CVD for the inspection will create intermittent and/or dewatered conditions in some areas of salmonid rearing habitat in the East Branch and main stem downstream. The inspection takes a minimum of two hours to complete, at which time flows are restored.

NMFS and the Corps have worked to minimize impacts to habitat from the pre-flood and periodic inspections. In 2004, the Corps installed Remote Automated Gate Controllers (RAGC) that allow for releases in increments of about 10 cfs. The Corps and NMFS agreed in 2004 that a 25 cfs ramp down increment should be implemented to attempt to meet the Hunter (1992) criteria, which would minimize beaching and stranding of juvenile steelhead as flows are reduced. Observations conducted during the action in 2004 suggest that the 25 cfs ramp down rate may not achieve Hunter's stage elevation criteria of

not more than two inches per hour. However, a balance must be achieved between ramp down rates and maintaining flow downstream during the two-hour flow shutdown. Ramp down rates of less than 25 cfs would likely meet Hunter's protective criteria for stranding of steelhead juveniles. Unfortunately, less flow would be available within the stilling basin and downstream reaches due to the additional time required for the ramp down at lower rates. As a result, the USACE would be unable to maintain flows in the East Fork and main stem Russian River during the 2-hour flow shutdown. Based on monitoring of past pre-flood inspection flow ramp downs, NMFS and the USACE believe that a 25 cfs ramp down rate will adequately minimize the occurrence of intermittent and dewatered habitats near the dam while allowing for adequate flow from the stilling basin to the river, which maintains instream habitat for steelhead further downstream during the two-hour shutdown.

d. Turbidity - Coyote Valley Dam

Highly turbid flows from CVD releases are expected to affect the fine sediment deposition pattern in the river channel. The accelerated rate and extended duration of fine sediment from CVD releases during flood and water supply operations[45] causes fine sediment to settle on, and intrude into, the substrate of the low flow river channel degrading the habitat value of the normally clean gravel substrates of the low flow channel. When the bulk of the suspended sediment load is captured in reservoirs and released at lower flows as occurs with CVD, the result is degraded salmonid spawning rearing habitat (Everest 1969; Badgered et al. 1991). It also reduces the diversity of habitat for benthic invertebrates and may eliminate certain guilds of invertebrates from the food chain reducing food availability for juvenile salmonids

Data are not available to reliably estimate the magnitude of turbidity or the impacts to salmonid habitat. Impacts to habitat could include sustained levels of high turbidity and sedimentation of riffle and pool areas in the Russian River below the confluence with the East Branch. Given the current adult escapement (1,500 to 6,000) of Chinook salmon in the upper mainstem we assume that adverse affects to Chinook salmon spawning and rearing habitat is low to moderate. Impacts on steelhead rearing habitat in this area of the Russian River may be of more concern.

2. Impacts to Species

Flow releases for flood control are likely to result in scour of Chinook salmon redds downstream from CVD. Impacts to listed salmonids from bank erosion, such as entombment of eggs due to increased sediments, and effects to juvenile rearing habitat are also likely. Ramp downs for flood control and water supply occur in the late winter and spring and are most likely to affect salmonid fry and juveniles. Pre-flood/periodic inspections occur in the fall and are most likely to affect juvenile steelhead. These fall inspections should not affect juvenile Chinook salmon because they will have migrated downstream out of the affected area prior to the fall.

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 five-miles (Ukiah Reach) are expected to cause mobilization of the streambed and adversely affect some Chinook redds. Based on the available information, NMFS estimates that 5 to 10

[45] Turbidity can result from both CVD flood control operations and CVD water supply releases. NMFS has placed the information on turbidity within the CVD Flood Control Operations section purely for editorial convenience.

percent of the Chinook 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 baseline channel conditions in the upper Russian River.

To estimate the number of Chinook salmon redds that may be scoured by CVD flood operations we utilize site specific Chinook redd counts reported by SCWA (2005*a*). SCWA (2005*a*) reports that the Ukiah Reach of the main stem is an important spawning area for Chinook salmon, with redd densities ranging from 12 redds/mile in 2006 to 25 redds/mile in 2002. Based on these densities, 60 to 125 Chinook redds could be exposed to total or partial scouring in the upper five miles of the main stem Russian River. Based on our estimate of 5 to 10 percent of Chinook redds expected to be scoured, we expect 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. Scour of Chinook salmon redds is expected to decrease survival of embryos and pre-emergent Chinook 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 1.5 to 2 year flood events occur in the upper main stem, or approximately seven to eight out of every fifteen years that CVD conducts flood control operations.

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.

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 redds are expected to be confined to short reaches below bank erosion sites.

Juvenile Chinook salmon and steelhead may benefit from bank failures along the upper main stem 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.

Both CC Chinook salmon and CCC 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 (Hunter 1992) 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. Ramp down rates of 250 cfs/hr at CVD are expected to produce river stage changes of 6 inches/hr. These stage changes, and those from the larger ramp down rates greater than 250 cfs/hr to the maximum rate of 1,000 cfs/hr, are likely to strand fry and juveniles, although, as

described above, some dampening of stranding effects may occur due to late winter and spring storms. Stranded fry and juveniles are likely to experience higher rates of predation. Some fry and juveniles are likely to 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 main stem Russian River below the East Branch is not expected to affect all Chinook and steelhead fry and juveniles inhabiting this 4 mile stream reach. 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 miles 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 strand, but not injure or kill, juvenile steelhead along the East Fork Russian River and main stem Russian River when flow is ramped down. Surveys conducted by NMFS and Corps 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. For example, increased predation by birds or other vertebrates on juvenile steelhead has not been observed during pre-flood surveys conducted by NMFS, SCWA, and the USACE from 1998-2004. 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. From 2002 through 2004, observations by NMFS and USACE indicate that fewer than 20 juvenile steelhead were stranded in disconnected pools during pre-flood or periodic dam inspections. Observations by survey teams indicate that the build up of gravel bars has confined the wetted stream, thereby reducing the potential for fishes to become stranded in disconnected pools.

High turbidity concentrations can reduce dissolved oxygen in the water column; the settling and intrusion of fine sediments into the gravels in which salmonids deposit their eggs can reduce hyporheic flow. Reduced levels of DO in the water column will delay or impair development of eggs and alevins. Reduced hyporheic flow will reduce DO delivery to developing eggs and alevins and impair the removal of metabolic wastes from the egg pocket. Chinook salmon and steelhead redds located in the upper main stem from Ukiah to Hopland are likely to be most affected by turbid water released from CVD. Due to the lack of site specific turbidity data for the upper Russian River reductions in egg and alevin survival from elevated turbidity cannot be quantified at this time. However, we assume that reductions in embryo and

alevin life stages are likely low to moderate given the current high production of Chinook and steelhead fry in the upper mainstem Russian River[46].

Effects to juvenile Chinook salmon and steelhead are likely to result from reduction in prey availability and feeding ability caused by turbid waters (Newcomb and Macdonald 1991). These effects can lead to reductions in juvenile Chinook salmon and steelhead growth that may effect survival. Based on observations made by NMFS staff biologists over the last 10 years, and Ritter and Brown (1971), persistent turbidity levels from CVD are estimated to be of the magnitude that cause slight to significant impairment to juvenile salmonids. These impairment ratings are based on Newcombe (2003) which provides an assessment method for fish exposure in turbid waters. Again, we are lacking data to make specific conclusions regarding the response of juvenile salmonids to persistent elevated turbidity that results from CVD releases. As above, we assume that reductions in embryo and alevin lifestages are likely low to moderate given the current high production of Chinook salmon and steelhead fry in the upper mainstem Russian River.

B. Hydroelectric Facility at Coyote Valley Dam

1. Impacts to Habitat, Including Critical Habitat

a. Flow Impacts Downstream

The LMHPP turbines at CVD can generate power at flows between 50 and 400 cfs. The LMHPP diverts water from Lake Mendocino's main outlet tunnel through hydraulic turbines via a tainter gate. In January 2007, the City of Ukiah and the USACE retrofitted the hydraulic tainter gate at CVD. The tainter gate was tested and is currently in operation at CVD. Monitoring of river stage elevations in the upper main stem by NMFS staff biologists during the operation of the new tainter gate confirmed that shifting from flood to power mode has little effect on river stage downstream of the dam. These finding are consistent with a technical assistance letter that was provided to the City of Ukiah by NMFS on February 15, 2006. In that letter, we communicated to the City our conclusion that operation of the retrofitted tainter gate would have no effect on Chinook salmon, steelhead or designated critical habitat if operated in a manner consistent with the City of Ukiah's August 25, 2005 Operations Plan.

b. Gas Super Saturation

Water spilling through dams and turbines becomes pressurized and can entrain nitrogen gas bubbles at higher than normal levels. Juvenile and adult salmonids that are localized in shallow water habitats with supersaturated levels of nitrogen can develop gas bubble disease as the result of accumulated nitrogen gas bubbles in the bloodstream. Salmonid mortality from gas bubble disease has been observed in other river systems, such as the Columbia and Snake rivers, where large dams and hydroelectric facilities receive exceptionally high flows (NWFSC 2000). There have been no indications that water leaving the LMHPP is saturated with nitrogen at levels harmful to adult or

[46] Although information is limited, the best available is observations made by NMFS staff in May of 2000 of large numbers of steelhead fry in this area of the Russian River during Corps CVD inspection activities. NMFS assumes that if steelhead fry are abundant in this area of the mainstem, Chinook fry, which would be exposed to similar turbidity levels, are also abundant. However, because steelhead juveniles remain in rivers and streams during the summers, additional data needed to confirm impacts to steelhead juveniles are limited.

juvenile salmonids (Corps and SCWA 2004). This lack of super-saturation can be contributed in part from the weir structures and low gradient at the outflow pipe that slows water velocity and allows gas held in suspension to diffuse back into the atmosphere.

2. Impacts to Species

No impacts to listed species are anticipated because no adverse changes to their habitats are anticipated from the operation of the LMHPP. Entrainment in the turbines will not occur because listed salmonids are not present upstream of the LMHPP.

C. Flood Control - Warm Springs Dam Operations

1. Impacts to Habitat, Including Critical Habitat in Dry Creek

Similar to the analysis of CVD operations described above, flood management and annual pre-flood and five-year periodic inspections at WSD have the potential to reduce flood peaks, contribute to streambed scour and bank erosion, raise turbidity levels, and during ramp-downs for flood releases cause dewatering or disconnection of off channel areas in portions of the channel.

a. Streambed Scour

The Corps and SCWA (2000*a*) indicate that flood releases (1,000 to 6,000 cfs) from WSD during the winter and spring are sufficient in some years to cause scour of salmon and steelhead spawning gravels in Dry Creek. NMFS agrees with the Corps and SCWA (2004) that current flood operation releases provide for a balance between the periodic mobilization of the streambed needed to clean spawning gravel, and the scour that can destroy salmonid embryos in redds. WSD flood releases that exceed 5,000 cfs are likely to cause some scour of coho salmon and Chinook salmon redds. WSD operations are expected to cause an overall reduction in the frequency of flows that are sufficient to scour salmonid redds in Dry Creek.

As described in the Environmental Baseline, after the construction of WSD the frequency of channel forming flows in Dry Creek downstream was reduced by flood control operations at the dam. NMFS expects these impacts to continue for the fifteen year period of the proposed project. WSD flood operations reduce the potential for redd scour by muting peak flood events Due to the reduced sediment transport caused by the construction of WSD, sediment in the channel downstream of WSD has likely been reduced. The reduction in peak flows from the operation of WSD reduces the potential for degradation of the remaining sediment load downstream of the dam.

Our analysis indicates that even though WSD reduces scour potential in most years, continued operation of the project as proposed for the next fifteen years may contribute to scour of salmonid spawning sites downstream of the project. NMFS concludes that initiation of scour in Dry Creek by WSD flood releases is expected in years when very large flood releases are made, about once in every ten years. The relatively small sized gravel substrates that coho salmon prefer for spawning are more vulnerable to scour than gravels used by steelhead or Chinook salmon (Corps and SCWA 2004). Based on the Corps and SCWA (2000*a*) scour analysis, NMFS concludes that initiation of scour in Dry Creek by flood releases is likely to occur approximately twice every 15 years (once in ten years is 1.5 times in 15

years). When scour occurs, a portion of the spawning habitat for all three salmonid species approximately 3 miles downstream of the dam is likely to be lost. As above with CVD, NMFS expects approximately 5-10 percent of spawning habitat to be scoured to a depth greater than redd depth based on channel conditions and salmonid spawning habitat locations below WSD.

b. Bank Erosion

WSD flows of 1,000 to 6,000 cfs are likely to contribute flows that would initiate bank erosion in some years. Based on the analysis of hydrologic data and flows needed to initiate bank erosion by the Corp and SCWA (2000*a*), it appears that WSD flood operations are not a significant factor that contributes to bank erosion in Dry Creek in most years. Bank erosion initiates in Dry Creek at flow releases of 2,500 cfs or greater (Corps and SCWA 2004). During most winter storm events WSD reduces bank erosion potential by reducing releases that result in a reduction in flood peaks. Conversely, when tributary flow is low, flood releases of 1,000 cfs or greater can contribute to elevate flows to 2,500 cfs or greater and initiate bank erosion processes. NMFS' review of WSD releases indicates that the 2,500 cfs threshold initiates bank erosion about 8 times in 15 years. Therefore we expect that some bank erosion is occurring along Dry Creek due to the contribution of flood releases from WSD flood operations.

We expect bank erosion to occur in relatively small localized areas along Dry Creek. A relatively dense riparian zone along the stream banks, bank stabilization projects, and adjustments in the channel capacity since the construction of WSD reduce the potential for bank erosion along Dry Creek. Small bank erosion failures are likely to deliver sediment and organic debris to the channel affecting salmonid spawning and rearing habitat. Localized effects to spawning habitat or redds may occur when fine bank materials enter the channel affecting spawning quality by increasing the fine sediment component of spawning sites. Delivery of fine sediment to Dry Creek could also reduce intergravel flow, or entomb salmonid embryos or alevins at existing redd locations.

c. Reduction in Winter Habitat Quality

Unlike the flood flow analyses done for CVD (with scour and bank erosion thresholds), information is not available for WSD and Dry Creek that provides thresholds for winter flows that would affect winter habitat quality. Therefore our analysis is based on reasonable inference and the identification of limited winter refuge habitat in Dry Creek as described in the *Environmental Baseline*.

Our analysis indicates that although operation of WSD reduces flood peaks in Dry Creek and downstream in the Russian River, the subsequent release of flows reduces the quality of winter habitat in Dry Creek. This is because after flood peaks are stored behind the dam, water must be released in some years to provide storage space for additional flood peak flows from subsequent storms. Flood releases may range from 1,000 to 6,000 cfs. These releases, although smaller than the preceding flood peaks, are likely large enough to force salmonids to seek refuge to avoid being swept downstream into even higher flows in the Russian River. Salmonids are known to seek cover from high winter flows (see for example, Quinn 2005).

Currently, winter refuge habitat in Dry Creek is limited due to channelization and lack of boulders and LWD in the channel as described above in the *Environmental Baseline* section. These conditions provide few areas where listed salmonids can escape from high flows released during the winter. Flood

flow releases in Dry Creek as proposed confine listed salmonids to the small areas of winter refuge that remain. Juvenile salmonids must eat during the winter to survive, and cannot forage during high winter flows.

d. Intermittent Flows and Dewatering

NMFS examined the potential for flow ramp-downs associated with flood releases and inspections at WSD to adversely affect rearing habitat in the main stem of Dry Creek. The Corps proposes to continue to use the interim ramping rates of 250 cfs/hr when flows are between 250 and 1,000 cfs, and 25 cfs/hr when flows are less than 250 cfs. When CVD releases flows of 1,000 cfs or greater, the ramping rates are limited to not more than 1,000 cfs on the ramp down, and not more than 2,000 cfs when ramping up.

NMFS and Corps staff conducted surveys of Dry Creek during pre-flood inspections to determine if these operations have a high potential to cause intermittent flow and/or dewatering of Dry Creek during ramp downs. NMFS and the Corps concluded that these impacts will be limited due to the relatively steep banks and the general lack of side-channels or other areas where flows could become intermittent or scarce (Tom Daugherty, NMFS, personal communication, Feb 22, 2007).

2. Impacts to Species

Flood operations likely cause minor scouring of spawning habitat in Dry Creek below WSD. WSD reduces the scour potential in Dry Creek during flood operations, but may expose salmonid redds to some scour potential during large flood releases. Estimating the number of Chinook salmon, coho salmon, and steelhead redds that may be destroyed by scour is difficult because although Corps and SCWA (2000*a*) analyzed scour potential, the amount of spawning habitat was not quantified. A realistic worst-case-scenario approach would result in most redds being scoured, and salmonid eggs and alevins lost, in some, but not all years in the three mile long segment between the dam and Pena Creek. Based on May et al. (2007), we estimate that 5 to 10 % of the salmonid redds are likely to be scoured during WSD releases of 5,000 cfs or greater. In some years, climate conditions will preclude the need for flood control releases, in other years, climate conditions are likely to result in only a few flood control releases. Below Pena Creek, Warm Springs flood releases may contribute to scour potential, but given the wide range of flow conditions, the specific effects to salmonid redds are expected to be minimal and not detectable.

Bank erosion contributed by WSD 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 Dry Creek. Chinook and coho salmon redds have the highest likelihood of occurrence due to the timing of redd construction that makes their spawning sites more susceptible to sedimentation. Steelhead redds are less likely to be affected due to the timing of redd construction, but some spawning sites may be affected. Effects to salmonid redds are expected to be confined to short reaches below bank erosion sites at a limited number areas. Adverse effects to salmonid sites can be quite variable with minor intrusion of fine sediment to redds, or in cases redd location may be covered with bank material that entered the stream channel. In either case we expect a decrease in success of salmonid embryos or alevins at the affected sites.

Juvenile Chinook salmon and steelhead may benefit from bank failures along the upper main stem Dry Creek. These failures typically deliver vegetation in the form of small and large organic debris that improves winter habitat for both salmonids, but is likely to improve rearing conditions for juvenile steelhead during the summer months. Dry Creek in particular has been found to be lacking velocity refuge areas that would be increased with the introduction of organic debris.

Juvenile steelhead and coho salmon that are unable to utilize the limited velocity refuges available in Dry Creek during the winter will be swept downstream during WSD releases and likely perish. Those that are able to find winter refuge habitat will have their feeding opportunities limited by WSD flood releases. Reduction in feeding may impact their fitness.

Although the risk of intermittent flows and/or dewatered conditions is low during ramp downs, CC Chinook salmon, CCC coho salmon, and CCC steelhead fry and juveniles in Dry Creek are likely to be exposed to adverse effects during flow ramp down actions. As previously noted, Hunter (1992) recommends ramping rates of one inch or less per hour to protect steelhead fry and 2 inches per hour to protect juvenile salmonids.

Ramp down rates (both 250 cfs/hr and 125 cfs/hr) for the current operating releases produce river stage changes of 6 inches/hr in the first 1.5 miles below WSD (Corps and SCWA 2004). Ramp down rates between 250 and 1,000 cfs/hr are expected to produce river stage changes greater than 6 inches/hr and are likely to have greater impacts on salmonid fry and juveniles in Dry Creek. Although the Corps and SCWA did not survey stage changes in the 1.5 mile reach between Pena Creek and the point 1.5 miles below the dam, NMFS field observations indicate that similar channel conditions are present in this reach. The stage changes expected in these areas of Dry Creek (the first 3 miles downstream of the dam) are expected to result in fry and juvenile stranding during ramp-downs. Downstream from Pena Creek natural inflow from tributaries will likely dampen the effects of ramp-downs. Cross sections evaluated further downstream (greater than 3 miles) from WSD were generally able to meet the Hunter criteria (Corps and SCWA 2000*a*).

Chinook salmon, coho salmon, and steelhead juveniles are most likely to become stranded by proposed ramping operations between February and late June when discretionary ramping is most likely to occur. However as described above, the steep banks and lack of side channels in this three mile segment are generally not conducive to high stranding rates. Therefore, we expect that relatively low numbers of juvenile salmonids will be stranded in isolated pools or beached due to WSD flow ramping actions. Beached fish will die in less than ten minutes due to asphyxiation. Stranded fish are more likely to be eaten by predators, or harmed by poor habitat conditions in the relatively small pools they are confined to.

Annual Pre-flood and five-year periodic inspections at WSD are unlikely to strand or kill listed salmonids in Dry Creek because 1) these inspections are scheduled for September to avoid impacts to adult spawning and to allow juvenile fish time to grow to sizes that reduce their potential for stranding, and 2) the USACE will provide a continuous 25 cfs minimum bypass during the two hour inspection. See Project Description III. 5.*d* for additional information on WSD inspections.

D. Warm Springs Dam Hydroelectric Facility

1. Impacts to Habitat, Including Critical Habitat

a. Flow impacts downstream

Operation of the WSD Hydroelectric Facility (WSDHF) does not impact flows downstream in Dry Creek. Water used in the WSDHF is part of the water used for flood control and D1610 requirements. Some of this water is diverted through the WSDHF turbine before traveling downstream to meet these needs and uses.

b. Gas Super Saturation

There have been no indications that water leaving the WSDHF is supersaturated with nitrogen gas (Corps and SCWA 2004). Water tested at the inflow to the WSFF is at saturation level, meaning that the levels of nitrogen gas saturated in the water are at normal levels.

2. Impacts to Species

Operation of this facility does not impact critical habitat or listed salmonids. There is no potential for entrainment of listed salmonid species in the turbine because they are not present upstream of the dam.

E. Hatchery Operations

The release of hatchery steelhead could be considered an impact on the critical habitat of Chinook salmon, coho salmon, and wild steelhead because hatchery steelhead may compete for food, prey upon salmonids, or introduce disease in aquatic habitats. However, because the impacts to salmonids in the Russian River are caused directly by the hatchery fish, we have chosen not to break this section into habitat effects followed by species effects. Effects are discussed below for each element of the steelhead hatchery program.

The DCFH and CVFF were intended to serve as mitigation for the loss of salmonid spawning and rearing habitat blocked by the construction of WSD and CVD. Annual escapement goals of 1,100 adult coho salmon, 6,000 adult steelhead and 1,750 adult Chinook salmon in the Dry Creek drainage, and 4,000 adult steelhead in the upper Russian River drainage, were established to provide mitigation for losses resulting from construction and operation of WSD and CVD, and enhancement of the Russian River (Corps 1986b). The previous coho salmon and Chinook salmon hatchery programs both ended in the late 1990's as described in the Environmental Baseline Section, resulting in the Corps not being able to meet established mitigation goals.

a. Emergency Water Supply Line

The Russian River coho salmon population is threatened by a potential catastrophic loss of fishes in the DCFH as the result of a possible failure of its current water supply. An Emergency Water Supply Line

(EWSL) was constructed at the WSD as a back-up water supply line to provide bypass flow to the DCFH and to Dry Creek during annual or periodic inspections. However, the current EWSL at WSD has proven unreliable in providing the necessary bypass flows, since its construction in 1992, and it has not been able to provide an emergency water supply flow to the DCFH or Dry Creek when needed. The fish hatchery is crucial to the RRCSCBP, and an EWSL is necessary to prevent the catastrophic loss of three brood years of coho salmon broodstock, as well as to prevent the catastrophic loss of juvenile steelhead held each year at the hatchery. Catastrophic losses of steelhead have recently occurred at the CVFF due to problems with the EWSL at CVD, resulting in mortality of 104,400 juvenile steelhead at the CVFF in January 2006. The Corps has already made improvements to the EWSL at CVFF, but there is no commitment to improve the EWSL at DCFH, which is the center for hatchery operations for the RRCSCBP.

b. Russian River Coho Salmon Captive Broodstock Program

The RRCSCBP is authorized under an ESA section 10(a)(1)(A) enhancement permit issued to CDFG (Permit 1067, modification 3). Since the effects of the current RRCSCBP are already described in the September 2001 biological opinion concerning the permit issued for that program, the effects associated with the RRCSCBP are not described in this section. Instead, the effects of the RRCSCBP are described in the Environmental Baseline section of this biological opinion and are considered as part of our evaluation of the entire "effects of the action" (50 CFR 402.02) in the *Integration and Synthesis of Effects*.

c. Steelhead Mitigation Program

The Steelhead Mitigation Program is funded by the Corps and is implemented by CDFG. The steelhead produced at DCFH and CVFF have recently been included in the listed DPS. A draft Hatchery and Genetic Management Plan (HGMP) has been developed for this program, however, it is currently incomplete.

As noted in Section III, the Corps (and CDFG) have recently taken initial steps to begin transitioning the steelhead mitigation program from an isolated hatchery program to an integrated hatchery program, and they have incorporated operational changes that have been implemented due to revisions in CDFG policy and guidelines (Corps and SCWA 2004). During the 2007 spawning season, CDFG began incorporating unmarked wild steelhead into the spawning of steelhead at both DCFH and CVFF. However, for the programs to become fully integrated, additional wild steelhead would need to be obtained and incorporated into the annual spawning regime at both facilities.

Genetic Effects. Despite historical releases of out-of-basin steelhead, there appears to be a significant amount of population structure remaining among California coastal steelhead stocks. Garza *et al.* (2004) examined multi-locus genetic data from 62 populations of steelhead in coastal California DPSs, and concluded that the population structure of steelhead in coastal California has been influenced primarily by migration. In addition, drift and local adaptation likely contribute to the differentiation between all populations in the study. Results from both Garza *et al.* (2004) and Deiner *et al.* (2007) suggest that the steelhead populations within the Russian River have not been dramatically altered by hatchery releases. Recent genetic information on Russian River steelhead indicates that there are no substantial genetic differences between wild and hatchery propagated steelhead in the basin, indicating a moderate gene flow among below-barrier anadromous sites (Deiner 2004; Diener *et al*. 2007). Steelhead straying in the watershed may also be occurring as a response to artificial barriers and excess adult off-site releases. As a

result, gene flow is likely occurring between hatchery and wild steelhead. Previous genetic work by Deiner *et al.* (2007) indicated a lack of significant divergence of hatchery steelhead produced at both facilities from steelhead returning to DCFH and CVFF and naturally spawning steelhead throughout the basin. Genetic diversity was also similar, indicating a lack of substantial reduction of effective population size of hatchery steelhead.

Based on genetic and other information at the time, beginning in the 2000/01 spawning season, NMFS directed CDFG to not incorporate wild steelhead into the spawning of steelhead returning to DCFH and CVFF, and to only spawn hatchery (adipose fin-clipped) steelhead. However, current information on the genetics of steelhead indicate that there are no substantial genetic differences between wild and hatchery propagated steelhead within the Russian River basin (Deiner 2004; Deiner *et al.* 2006); therefore, the exclusion of wild steelhead from spawning is no longer recommended. Continued exclusion of wild steelhead from hatchery spawning stock could result in a divergent hatchery population with consequent loss of genetic diversity and increase in inbreeding. (C. Garza, NMFS Southwest Fisheries Science Center, personal communication, May 3, 2007). Therefore, the steelhead hatchery programs should be operated as integrated harvest programs[47].

In hatchery programs, inbreeding and hatchery/domestication selection can result in fish that are not only less fit, but also negatively influence naturally spawning populations through the exchange of migrants. This can occur by multiple mechanisms, including reduction of effective size through the Ryman-Laikre effect or through competitive interactions that result in overall loss of population fitness. Unfortunately, such effects can not be evaluated with the sort of population genetic structure study provided by Deiner *et al.* (2007), particularly since the lack of divergence could be largely due to straying of hatchery fish into the naturally spawning tributary populations. However, careful evaluation and mitigation of any potential detrimental effects of hatchery production on the ESA-listed CCC steelhead DPS can be achieved through genetic management of broodstock and consequent genetic monitoring.

Competition and predation. DCFH/CVFF hatchery steelhead may compete with wild steelhead as outplanted surplus hatchery adults, as straying hatchery adults that return to tributaries and the mainstem to spawn, or as out-migrating juveniles that compete for food and rearing habitat. Direct competition for food and space can result in displacement of wild fish into less preferred areas.

Adult hatchery steelhead that return from the ocean and stray into tributaries and relocated surplus adult hatchery steelhead may spawn in tributaries. Salmonid straying can be advantageous to long-term population sustainability by facilitating colonization of habitat and maintaining genetic diversity within small populations, and is inherent at some rate in natural populations (Hard et al. 1992). However, high rates of straying may have deleterious effects on native fish genomes and local adaptations, and lead to homogenization of populations with loss of diversity within and among populations (Williamson and May 2005, CDFG/NMFS 2001). Steelhead release strategies for DCFH and CVFF appear to reinforce homing to the facilities, as adult numbers have been sufficient or in excess of broodstock program needs. The incidence of straying hatchery steelhead has not been quantified for the Russian River basin, and would be compounded by the non-spawned adult hatchery steelhead that are planted into the mainstem Russian River and tributaries.

[47] Hatchery program in which artificially propagated fish are produced primarily for harvest and they are intended to spawn in the wild, and are fully reproductively integrated with a particular natural population.

Competition for spawning area and mates between hatchery and wild adult steelhead is anticipated to primarily occur in the tributaries, however, monitoring to determine the level of competition is lacking. The amount of competition is dependent upon the total number of steelhead present, number of ripe females, and the amount of available spawning habitat. Based on genetic results, hatchery steelhead and wild steelhead are spawning together which has resulted in an integrated population. Since release strategies for steelhead produced at DCFH and CVFF appear to reinforce adults returning the hatchery facilities, NMFS expects that only a low level of straying is occurring.

Adult hatchery steelhead that return to CVFF and are not needed for broodstock are relocated and released into tributaries to the upper Russian River including: Ackerman, Feliz, Orr, Gibson, Doolan, Mill (tributary to Forsythe), Hensley, McClure, McNab, Morrison, Parsons, Howell, Dooley, McDowell, Twining, and Walker creeks. These urban tributaries were selected by CDFG due to the present lack of wild steelhead, and the potential to re-establish steelhead in these tributaries. The potential competition between natural and hatchery steelhead in these urban tributaries is probably low, due to the present lack of wild steelhead in these streams.

The smolt release strategy is intended to minimize interactions with Russian River wild steelhead, Chinook salmon and coho salmon. Released hatchery steelhead are only expected to be in the watershed for a short amount of time, entering the estuary within a few weeks (Corps and SCWA 2004). However, DCFH/CVFF steelhead smolt releases and outmigration timing does overlap with emigration of wild steelhead, wild and hatchery coho salmon, and wild Chinook salmon smolts. Based on research conducted in Scott Creek, a small coastal stream, it was determined that hatchery steelhead smolts emigrated quickly with little interactions with wild salmonids (Hayes *et al.* 2004). DCFH steelhead smolts are transported and released into Dry Creek three miles downstream from the hatchery at Yoakim Bridge to facilitate outmigration. CVFF steelhead smolts leave the fish facility volitionally to enter the East Branch Russian River, which promotes natural transit behavior and has less impact on the carrying capacity (ISAB 1998). Since releases of hatchery steelhead smolts occur at or near each facility, competition between DCFH/CVFF steelhead and wild juvenile salmonids is likely concentrated downstream of WSD and CVD (*i.e.*, in Dry Creek and the main stem). There may be greater potential for competition from CVFF steelhead, since they are released higher in the basin and have to migrate longer distances than DCFH steelhead (Corps and SCWA 2004).

Hatchery steelhead smolts are larger than their wild counterparts, suggesting that predation by hatchery fish may occur on wild salmonid fry and fingerlings that are encountered during downstream migration, or during extended rearing. Although the effects are anticipated to be primarily in the mainstem Russian River and Dry Creek, there is a potential for hatchery smolts to prey on and compete with rearing wild juvenile steelhead and juvenile coho salmon in tributaries. Since the steelhead are released as smolts, and smolts typically emigrate downriver quickly, very few hatchery juvenile steelhead are anticipated to enter tributaries, minimizing the potential for predation and competition with wild steelhead and coho salmon.

Hatchery releases may also have an indirect effect on predation. Potential migratory behavioral interaction between hatchery and wild fish include a downstream schooling influence. This refers to the downstream sweeping of wild fish by large numbers of downstream migrant hatchery fish, known commonly as the “pied piper effect” (Weber and Fausch 2003). Large concentrations of migrating hatchery steelhead may attract predators (fish, birds, and seals) and consequently contribute indirectly to

predation of wild steelhead. This potential is greater for the DCFH releases since large numbers of smolts are released at a time; the potential is lower at the CVFF releases because steelhead are left to leave the facility on their own volition. Therefore, predation on wild and hatchery juvenile steelhead is most likely occurring at low levels primarily in Dry Creek, mainstem Russian River, and within the estuary, where DCFH steelhead smolts commingle with wild salmonids.

Disease transmission. Stress induced by crowding or injury, and the presence of pathogens, can easily induce outbreaks of fish disease in the hatchery setting (Wood 1979). Fish health is monitored by a CDFG Fish Health Center pathologist, following procedures adopted by the Fish and Game Commission (W. Cox, CDFG Senior Fish Pathologist, personal communication). Prophylactic and therapeutic treatments are carried under the conditions of National Pollutant Discharge Elimination System [NPDES] permits required by the State Water Quality Control Boards, and treated fish are not released before completion of depuration periods. Disease prevention is assisted by hatchery sanitation protocols and with quality fish nutrition. The DCFH steelhead program has previously had bouts of Coldwater Disease (causative agent *Flexibacter psychrophilus*), which is discouraged by disinfection of fertilized eggs, use of hatching jars to prevent water-borne transmission, and treatment of swim-up fry and juveniles with antibiotic Penicillin-G to combat occurrence. Bacterial kidney disease (BKD), (causative agent *Renibacterium salmoninarum*) has a low incidence of infection. As standard hatchery protocol, ovarian fluid is collected from one subset of 20 females from DCFH and one from CVFF, and screened for incidence of BKD to control for infection in the egg (FishPro 2004). BKD transmission can also occur horizontally, via a carrier or diseased fish in the water supply. There may be a risk of releasing BKD-infected excess hatchery steelhead adults, though it is believed that the BKD pathogen is widely present in wild salmonid stocks. Although measures are implemented to reduce the potential for disease within the hatchery, if an outbreak occurs the disease could have an impact on steelhead rearing in the hatchery. The decision to release diseased fish is made by the CDFG Fish Pathologist on a case by case basis (W. Cox, CDFG Senior Fish Pathologist, personal communication). Diseased steelhead may be released if the pathogen is found in receiving waters, or there is no risk of transmission such as in terminal waters or waters with no outlet, *etc.* If the release of diseased steelhead has the potential to spread the disease to wild steelhead, the pathologist will consider the destruction of the fish. These measures reduce the likelihood and potential of transmitting the disease to wild steelhead.

Increased angling effects. Recreational fishing is allowed by CDFG throughout the year on the Russian River mainstem and Dry Creek for hatchery steelhead as well as other species such as smallmouth bass, catfish (*Ictaluridae*) and shad (*Alosa sapidissima*). Fishing is prohibited in the tributaries. Most steelhead fishing occurs during late fall through early April when adult steelhead return from the ocean to spawn. Recreational fishing for hatchery steelhead undoubtedly causes take of listed salmonids, including the hatchery steelhead, wild steelhead, as well as Chinook salmon and possibly coho salmon. Absent approval of a Fishery Management and Evaluation Plan (FMEP) under rules promulgated pursuant to section 4(d) of the ESA, the capture of listed steelhead, including hatchery steelhead, or Chinook salmon in these fisheries is in violation of sections 4(d) and 9 of the ESA. Capture of coho salmon during recreational fishing is in violation of section 9 of the ESA absent exemption through section 7 or 10 of the ESA.

Adult hatchery steelhead that return to DCFH but are not needed for broodstock are relocated and released into the mainstem Russian River upstream from the mouth of Dry Creek. Adult hatchery steelhead that return to CVFF and are not needed for broodstock are relocated to the Ukiah and Cloverdale reach of the

mainstem Russian River. The adult release locations in the mainstem Russian River are intended to reduce the chances of the steelhead returning back to facilities and increase the recreational fishing opportunity within the main stem Russian River.

Relocation of excess DCFH and CVFF steelhead adults to favored angling sites may increase fishing effort on wild steelhead present in those areas. Angling pressure can affect wild and hatchery steelhead through capture, handling, incidental hooking injury, or mortality. CDFG's draft FMEP for CCC Steelhead (2001) proposes the upper limit of increased mortality due to sport fishing to be 2.5 percent in all populations, based on an estimated mortality rate of 5 percent on hooked fish (Schill and Scarpella 1997). Russian River harvest effort data collected from returned angler cards in 1999, 2001, and 2002, reported that wild steelhead comprised 46, 34, and 29 percent, respectively, of the total steelhead catch (FishPro 2004). The majority of wild fish were released (93 to 98 percent) and on average over half (41-65 percent) of the hatchery steelhead were also released. Injuries related to hook and line capture are influenced by hook size and type, bait or lure choice, and species behavior. Common hook and line injuries include damage to the skeletal structure of the mouth, injury to gills, and secondary infections. Fish may be additionally stressed from handling, especially if the fish is kept out of the water before it is released. Since the majority of wild steelhead are caught with barbless hooks and released upon capture, the main effect to wild steelhead is stress, injury, and some delayed mortality. According to Bendock and Alexandersdottir (1993), mortality resulting from hook and line capture and release averaged 7.5 percent with wound location and bleeding as primary factors associated with mortality, and most mortalities occurred within 72 hours of release. Mortality rates for wild steelhead or salmon caught in the Russian River are probably less than that reported by Bendock and Alexandersdottir, because those researchers reported mortality of Chinook salmon that 1) were apparently caught without barbless hook restrictions, and 2) incurred the stress of being caught and radiotagged. Although more monitoring is needed to better quantify the effects of fishing on wild salmonids, NMFS assumes that only a small percentage of the wild salmonids captured will result in mortality as a result of the increased fishing effort.

Effects to adult Chinook salmon. Adult Chinook salmon are sometimes trapped at DCFH and CVFF during broodstock collection of steelhead for the steelhead hatchery programs. Low numbers of adult Chinook salmon are trapped at DCFH and relocated to the Russian River annually. The average number of Chinook salmon encountered at DCFH for the last 10 years is approximately 99 adults, with a range of 2 to 306 adults. Adult Chinook salmon are trapped less frequently at CVFF and have only been encountered in 4 of the last 10 years, with an average of 3, and range of 0 to 23 adults. The primary effects to adult Chinook salmon trapped and relocated from both facilities are non-lethal and related to stress, minor injury associated with capture, handling, and transport to release sites in the Russian River.

F. Flow Management

The project will continue to manage WSD and CVD for purposes of water supply during the low flow season (roughly late May through October) in a manner similar to recent historic project operations. These operations heavily regulate the flow in the main stem Russian River and the lower 14 miles of Dry Creek. Russian River flows are also influenced by reservoir operations at Lake Pillsbury and the associated diversions of water from the Eel River to the Russian River via the Potter Valley Project (PVP). Operations at CVD and WSD moderate peak flows in the Russian River and Dry Creek during high runoff events in winter, and together with the diversions at the PVP, they substantially augment flows during the low flow season. Although the inter-basin transfer of water at the PVP is not under the control of Corps

or SCWA, most of the water diverted to the Russian River at PVP passes through Lake Mendocino and is subject to control (*i.e.*, storage and release) by operations at CVD.

The project must make water supply releases from Lake Sonoma and Lake Mendocino in accordance with minimum flow criteria established in 1986 by Decision 1610 (D1610) of the SWRCB. Section III.B.1 of this opinion reviews those minimum flow criteria. Although D1610 provides minimum flow standards for the main stem Russian River and the lower 14 miles of Dry Creek, it does not provide standards for an upper limit to the amount of stream flow that may be discharged down these rivers. SCWA's use of the Russian River and Dry Creek as conduits for transmitting water supply from Lake Sonoma and Lane Mendocino during the low flow season has resulted in stream flows that are often more than 40 cfs higher than minimum flows under D1610, which are, in turn, much higher than either natural conditions or flows providing substantial, good quality habitat.

1. Flow-Habitat Assessment Study

Between 1999 and late 2001, SCWA, the Corps, and NMFS discussed alternative methods for assessing the effects of summertime flow releases from WSD and CVD on downstream salmonid habitats. In a letter dated February 7, 2000 to the Corps, NMFS recommended that the assessments be done using additional field measurements and habitat simulation (modeling) followed by a flow demonstration study involving observations by an interagency study team. Habitat modeling to address instream flow needs for fishes is often accomplished using the Instream Flow Incremental Methodology (IFIM) (Bovee 1982). In a letter dated January 2, 2001 to the Corps, NMFS specifically recommended that the IFIM be employed to address habitat flow relations in stream segments affected by project water releases. However, SCWA declined to use this highly quantitative method for addressing this issue. Instead the SCWA, DFG, Corps, and NMFS collaborated in a Demonstration Flow Assessment study to examine the effects of the artificially elevated summer flows on salmonids in the upper Russian River and Dry Creek (Annear *et al* 2004; Railsback and Kadvany 2008). That study, which was conducted in fall 2001, provides the best available information for evaluating the impacts of flow management at the two major Russian River dams on rearing habitats for salmonids. It also provides the best data for evaluating alternatives for minimizing those impacts. The study, which is reported as Appendix F of Corps and SCWA (2004), indicates that the current operations (*i.e.*, water releases) at WSD and CVD between late spring and early fall create excessively high current velocities that limit the amounts of rearing habitat for coho salmon, Chinook salmon, and steelhead in the upper Russian River and Dry Creek. The study found that these river segments support much more rearing habitat for salmonids when summer releases from the dams are lower. To understand the effects of flow management at the two dams and possible alternatives for minimizing impacts to salmonids, it is necessary to review the results of the interagency flow-habitat study.

The 2001 flow-habitat study employed a panel of fishery biologists with expertise in salmonid habitat assessment. The expert panel rated the quality and quantity of rearing habitats for salmonid species at nine study sites in Dry Creek below WSD and 13 study sites in the upper Russian River between the mouth of the East Branch and the city of Cloverdale. Each study site was approximately 200 to 300 ft in length and spanned the width of the wetted channel. At each study site, a panel of at least eight biologists estimated the percentages of the wetted surface area having 1) *suitable* and 2) *optimal* quality habitat for *fry* and older *juvenile* stages of the three salmonid species. Each of the study sites was rated at three separate flows. Sites in Dry Creek were evaluated after flows stabilized following releases of 47, 90, and

130 cfs from WSD; sites in the upper Russian River were evaluated at flows following releases of approximately 125, 190, and 275 cfs from CVD. Comparison of the percentages of available habitat at alternative flows was facilitated by the fact that the surface area of each study site did not change appreciably between study flows. This was so because the study flows were all higher than "natural" late-summer conditions and wetted width increased minimally across the range of study flows.

The study's panel of biologists reached consensus on the estimated amount of suitable and optimal habitat that was available at each of the study sites in Dry Creek and the upper Russian River. For Dry Creek, the lowest flow (47 cfs) generally provided greater amounts of habitat for each of the evaluation species life stages (Table 22). The suitability of habitat was strongly influenced by depth and velocity conditions provided by each flow; instream cover and velocity refuges were also important factors affecting habitat value. Specific habitat criteria are identified in the interagency flow-habitat assessment. Specifically, the flow-habitat study results show the following for Dry Creek:

a. Steelhead rearing in Dry Creek

- Of the three study flows, the lowest (47 cfs) provided the greatest amount of *suitable* and *optimal* habitat for both the fry and juvenile stages of steelhead.

- Eight of the nine study sites had substantially more *suitable* habitat for steelhead fry at 47 cfs than at 90 cfs or 130 cfs.

- Seven of nine study sites had substantially less *suitable* habitat for juvenile steelhead at 130 cfs than at a flow of 90 cfs or 47 cfs. Of the remaining two sites, only one site had the highest amount of *suitable* juvenile habitat at 130 cfs, and at the other site available *suitable* habitat for juvenile steelhead was about equal at all three study flows.

- As flows increased, the decrease in available steelhead habitat was significant. At several study sites the amount of *suitable* habitat for steelhead fry declined from more than 60% of the total wetted area to less than 25% of the wetted area when flow rose from 47 to 130 cfs. At several sites the area of *optimal* habitat for fry and juvenile stages of steelhead declined from more than 25% of the total channel area to less than 10% of the channel area as flow rose from 47 to 130 cfs. In this assessment, sites rated as having less than 10% suitable or optimal habitat often had very little or no habitat for that life stage.

b. Coho salmon rearing habitat in Dry Creek

- *Suitable* and *optimal* quality habitats for coho salmon fry were more available at 47 cfs than at the higher flows. However, even at 47 cfs rearing habitat for coho salmon was limited because of the general lack of deep pools and instream cover (*e.g.* large woody debris) that provide shelter from predators and refuge from high current velocities.

- The lowest flow, 47 cfs, provided the greatest amount of *optimal* habitat for coho fry: at 47 cfs, two sites provided *optimal* fry habitat in 10-25% of the wetted channel area; whereas at both 90 and 130 cfs, only one site provided 10-25% *optimal* habitat for fry.

- The greatest amount of *suitable* habitat for juvenile coho was observed at 47 cfs at which three sites were rated 10-25% and one site was rated as having 25-40% of its wetted area providing *suitable* juvenile coho habitat. At 90 cfs only two sites were rated 10-25% and one site was rated 25-40%; at 130 cfs only two sites were rated 10-25%, and no sites were rated 25-40%.

- Flows of 47 and 90 cfs appear to provide equal amounts of *optimal* habitat for juvenile coho, and these lower two flows provide more optimal habitat than 130 cfs. Only one site had more than 10% *optimal* juvenile habitat at 47 and 90 cfs; however, no sites had more than 10% *optimal* juvenile habitat when flow was 130 cfs.

c. Chinook salmon rearing habitat in Dry Creek

- Flows of 47 and 90 cfs provided approximately similar amounts of *suitable* and *optimal* habitats for the fry and juvenile stages of Chinook salmon; whereas a flow of 130 cfs provided substantially less *suitable* and *optimal* rearing habitat for Chinook salmon than 47 or 90 cfs.

- At three of nine study sites more than 40% of the stream channel provided *suitable* habitat for Chinook fry when flow was 90 cfs or less; whereas no study sites had more than 40% of their channel area providing *suitable* fry habitat when flow was 130 cfs.

- Five out of nine study sites had more than 10% of the channel area providing *optimal* habitat for Chinook fry when flow was 90 cfs or less; whereas at 130 cfs, only one study site had more than 10% of the channel area providing *optimal* fry habitat.

For the upper Russian River, the assessment team did not rate habitats for coho salmon because the relatively warm summer water temperatures in this segment preclude this area as coho rearing habitat. Similar to Dry Creek, the lowest study flow (in this case a release of 125 cfs from CVD) generally provided greater amounts of rearing habitat for steelhead and Chinook salmon. Specifically, the flow-habitat study results (Table 23) show the following for the upper Russian River:

a. Steelhead rearing habitat in the main stem

- The amount of available habitats for juvenile stages of steelhead (*i.e.*, fry and juvenile) declined substantially as releases at CVD increased above 125 cfs, the lowest of the three study flows.

- Eleven of 13 study sites had substantially more *suitable* habitat for steelhead fry at dam releases of 125 cfs than at 190 cfs or 275 cfs.

- At 8 of 13 sites, the greatest amount of *optimal* habitat for steelhead fry occurred at CVD releases of 125 cfs; 10 of 13 had the greatest amount of *optimal* fry habitat at either 125 cfs or 190 cfs (or both);

none of the 13 study sites had the highest amount of *optimal* fry habitat at releases of 275 cfs, although 3 sites had equal amounts of *optimal* habitat for steelhead fry at all three study flows.

- Eight of the 13 sites had the highest amount of *suitable* habitat for steelhead juveniles at releases of 125 or 190 cfs; only 2 sites had higher amounts of *suitable* juvenile steelhead habitat at 190 cfs.

- Seven of the 13 sites had the highest amount of *optimal* habitat for juvenile steelhead at releases of 125 or 190 cfs (or both); only 1 study site had higher amounts of *optimal* habitat for juvenile steelhead at the release of 275 cfs.

b. Chinook salmon rearing habitat in the main stem

- Of the three study flows, the greatest amounts of habitat for the fry and juvenile stages of Chinook salmon occurred at the lowest CVD release of 125 cfs.

- Ten of the 13 study sites had substantially more *suitable* habitat for Chinook salmon fry at dam releases of 125 cfs than at 190 cfs or 275 cfs; 7 out of 13 sites had the highest amount of *optimal* fry habitat at a release of 125 cfs; All thirteen study sites had higher amounts of *optimal* fry habitat at either 125 or 190 cfs than at 275 cfs.

- Eight of 13 study sites had more suitable habitat for juvenile Chinook salmon at 125 cfs than at the two higher flows; only 1 study site had higher amounts of suitable habitat for juvenile Chinook salmon at the release of 275 cfs.

- Nine of the 13 sites had the highest amount of *optimal* habitat for juvenile Chinook salmon at releases of 125 or 190 cfs (or both); no study sites had higher amounts of *optimal* habitat for juvenile steelhead at the release of 275 cfs.

Table 22. The percentage of wetted area of nine study sites in Dry Creek having suitable and optimal habitats for the fry and juvenile stages of Chinook salmon, coho salmon, and steelhead trout.

Life Stage	Habitat Quality	Flow (cfs)	Study Site								
			1	2	3	4	5	6	7	8	9
Chinook fry	Suitable	47	40-60	10-25	10-25	<10	>80	10-25	10-25	40-60	<10
		90	40-60	10-25	10-25	<10	40-60	25-40	10-25	40-60	<10
		130	25-40	10-25	<10	<10	25-40	10-25	<10	10-25	<10
	Optimal	47	25-40	<10	<10	<10	60-80	10-25	<10	25-40	<10
		90	25-40	<10	<10	<10	40-60	10-25	10-25	10-25	<10
		130	<10	<10	<10	<10	<10	<10	<10	10-25	<10
Chinook Juvenile	Suitable	47	25-40	10-25	10-25	<10	40-60	25-40	10-25	40-60	10-
		90	>80	10-25	10-25	<10	40-60	25-40	25-40	40-60	<10
		130	25-40	<10	<10	<10	25-40	<10	10-25	10-25	<10
	Optimal	47	<10	<10	10-25	<10	25-40	10-25	<10	40-60	<10
		90	60-80	<10	10-25	<10	25-40	10-25	10-25	10-25	<10
		130	10-25	<10	<10	<10	10-25	<10	<10	10-25	<10
Coho fry	Suitable	47	10-25	<10	<10	<10	10-25	<10	10-25	25-40	<10
		90	<10	<10	<10	<10	25-40	<10	10-25	10-25	<10
		130	10-25	10-25	<10	<10	10-25	<10	<10	10-25	<10
	Optimal	47	<10	<10	<10	<10	10-25	<10	<10	10-25	<10
		90	<10	<10	<10	<10	10-25	<10	<10	<10	<10
		130	10-25	<10	<10	<10	<10	<10	<10	<10	<10
Coho Juvenile	Suitable	47	10-25	10-25	<10	<10	10-25	<10	<10	25-40	<10
		90	10-25	<10	<10	<10	25-40	<10	10-25	<10	<10
		130	10-25	<10	<10	<10	10-25	<10	<10	<10	<10
	Optimal	47	<10	<10	<10	<10	<10	<10	<10	10-25	<10
		90	<10	<10	<10	<10	10-25	<10	<10	<10	<10
		130	<10	<10	<10	<10	<10	<10	<10	<10	<10

Table 22 continued.

Life Stage	Habitat Quality	Flow (cfs)	1	2	3	4	5	6	7	8	9
Steelhead fry	Suitable	47	60-80	25-40	40-60	10-25	>80	60-80	25-40	60-80	10-25
		90	60-80	10-25	25-40	<10	10-25	25-40	10-25	40-60	<10
		130	60-80	10-25	<10	<10	10-25	10-25	<10	10-25	<10
	Optimal	47	10-25	10-25	25-40	<10	40-60	60-80	10-25	40-60	<10
		90	60-80	<10	10-25	<10	10-25	10-25	10-25	10-25	<10
		130	25-40	<10	<10	<10	<10	<10	<10	10-25	<10
Steelhead Juvenile	Suitable	47	10-25	40-60	40-60	25-40	40-60	40-60	10-25	40-60	10-25
		90	25-40	25-40	25-40	<10	40-60	25-40	10-25	40-60	10-25
		130	40-60	10-25	10-25	<10	25-40	<10	10-25	25-40	<10
	Optimal	47	<10	40-60	25-40	10-25	10-25	25-40	<10	25-40	<10
		90	10-25	10-25	10-25	<10	25-40	10-25	10-25	25-40	<10
		130	10-25	<10	<10	<10	10-25	<10	<10	10-25	<10

Table 23. The percentage of wetted area of 13 study sites in the upper Russian River having suitable and optimal habitats for the fry and juvenile stages of Chinook salmon and steelhead trout.

Lifestage	Habitat Quality	Flow (cfs)	Study Site 1	2	3	4	5	6	7	8	9	10	11	12	13
Chinook fry	Suitable	125	25-40	10-25	<10	60-80	40-60	10-25	25-40	25-40	25-40	25-40	25-40	25-40	25-40
		190	10-25	10-25	<10	25-40	10-25	<10	<10	10-25	10-25	10-25	<10	10-25	10-25
		275	<10	<10	<10	10-25	10-25	<10	40-60	10-25	10-25	<10	<10	<10	10-25
	Optimal	125	25-40	<10	<10	10-25	25-40	<10	<10	10-25	10-25	10-25	10-25	10-25	25-40
		190	<10	10-25	<10	<10	10-25	<10	<10	<10	10-25	10-25	<10	<10	<10
		275	<10	<10	<10	<10	10-25	<10	<10	<10	<10	<10	<10	<10	10-25
Chinook juvenile	Suitable	125	40-60	10-25	10-25	40-60	25-40	<10	10-25	10-25	10-25	40-60	25-40	10-25	40-60
		190	10-25	25-40	<10	40-60	10-25	<10	10-25	10-25	<10	10-25	10-25	<10	25-40
		275	10-25	<10	<10	25-40	10-25	<10	40-60	10-25	<10	10-25	<10	<10	10-25
	Optimal	125	25-40	10-25	<10	<10	25-40	<10	<10	10-25	10-25	40-60	25-40	<10	25-40
		190	10-25	10-25	<10	10-25	10-25	<10	10-25	10-25	<10	10-25	<10	<10	10-25
		275	<10	<10	<10	10-25	10-25	<10	<10	<10	<10	<10	<10	<10	10-25
Steelhead fry	Suitable	125	25-40	<10	10-25	25-40	40-60	10-25	10-25	25-40	25-40	25-40	25-40	25-40	25-40
		190	10-25	10-25	<10	10-25	25-40	<10	<10	10-25	10-25	10-25	<10	10-25	10-25
		275	<10	<10	<10	10-25	10-25	<10	40-60	10-25	10-25	<10	<10	<10	10-25
	Optimal	125	25-40	<10	10-25	<10	25-40	<10	10-25	10-25	10-25	25-40	25-40	10-25	10-25
		190	<10	10-25	<10	<10	10-25	<10	<10	<10	10-25	10-25	<10	<10	10-25
		275	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10-25
Steelhead juvenile	Suitable	125	40-60	10-25	10-25	10-25	40-60	10-25	10-25	10-25	40-60	60-80	60-80	10-25	25-40
		190	25-40	25-40	<10	10-25	25-40	<10	10-25	10-25	<10	25-40	25-40	10-25	25-40
		275	10-25	10-25	10-25	25-40	10-25	<10	40-60	10-25	<10	10-25	10-25	<10	25-40
	Optimal	125	10-25	<10	<10	<10	25-40	<10	<10	10-25	25-40	40-60	40-60	<10	10-25
		190	10-25	10-25	<10	<10	10-25	<10	10-25	10-25	<10	25-40	10-25	<10	10-25
		275	10-25	<10	<10	10-25	10-25	<10	<10	<10	<10	<10	<10	<10	10-25

We approached the assessment of the effects of flow management between late spring through mid-fall by first identifying the stream flows that result from project operations. We then examined the effects of those stream flows on the quality of habitats for listed salmonids. The interagency flow-habitat study and water temperature data and modeling (Corps and SCWA 2004) provided the basis for that habitat analysis. Finally we considered the effects that project altered habitats would have on individual salmonids and relevant salmonid populations. The following sections separately address the effects of flow management by SCWA on salmonids in Dry Creek and the main stem Russian River.

2. Dry Creek - Effects on Habitat, including Critical Habitat

SCWA proposes to manage Lake Sonoma water supply through releases at WSD in a manner similar to recent past practices. This plan will continue to affect the following PCEs of critical habitat in Dry Creek: 1) juvenile rearing for all three listed salmonids, 2) adult migratory habitat of Chinook salmon, and 3) spawning of Chinook salmon. The migration and spawning habitats of steelhead should not be affected by SCWA flow management, because adult steelhead migrate and spawn during the winter months and early spring when WSD is managed by the Corps for flood control and SCWA diversions for water supply are satisfied by natural flow in the Russian River. Likewise, migration and spawning habitat for coho salmon in Dry Creek will likely not be affected by releases for water supply because this species typically spawns from November through January, when flows are naturally elevated and under the control of the Corps for flood protection. The absence of observations of coho salmon at the monitoring station at the seasonal Mirabel rubber dam (SCWA 2005*b*) suggests that, unlike other salmonid species, adult coho salmon do not ascend the Russian River to Dry Creek until at least after seasonal rains increase flows in the Russian River and the Mirabel dam is deflated.

SCWA's proposed flow management will continue to greatly influence the quality and quantity of PCEs of critical habitat for the rearing of steelhead, Chinook salmon, and coho salmon in the 14 mile segment of Dry Creek below WSD. The minimum flow requirements for Dry Creek under D1610 will have little bearing on the actual flows released from WSD from late spring through October. During this period, releases from WSD are highly dependent on water supply demand. Although minimum flow requirements under D1610 are less during dry years, water supply demand from Lake Sonoma is anticipated to be higher during dry years (Corps and SCWA 2004), and thus flows in Dry Creek would likely be higher during dry years. During the past fifteen years, WSD has generally sustained releases of more than 110 cfs for many weeks or months during the summer (see baseline section V.C.2). During the relatively dry years of 2001 and 2002, the median monthly flow released from WSD frequently exceeded 125 cfs during July, August, and September, and during that time flows in excess of 140 cfs were sustained for many weeks (Table 15). The interagency flow-habitat assessment study, described above, found a clear negative relationship between flow and availability of rearing habitat for juvenile salmonids. Much of Dry Creek provides optimal quality rearing habitat for steelhead at a dam release of 47 cfs; whereas at 130 cfs optimal quality habitats for rearing steelhead are nearly absent. The observed flow of 90 cfs provided intermediate amounts of rearing habitat for this species. The principal factor governing the flow-habitat relationship for steelhead rearing habitat is the current velocities that increase with flow and eventually exceed the tolerance of age 0+ and 1+ steelhead. SCWA's plan to maintain status quo operations at WSD will provide very limited

amounts of suitable and optimal quality habitats for rearing steelhead and minimal amounts of rearing habitat for coho and Chinook salmon.

In contrast to the effects on rearing habitat, the proposal to manage Dry Creek flows in a manner similar to recent operations will likely provide good quality conditions and PCEs of critical habitat for adult migration and spawning of Chinook salmon in Dry Creek. Annual monitoring by SCWA documented a substantial annual run of Chinook salmon in the Russian River that precedes the onset of naturally elevated flows associated with seasonal rains. Video monitoring at the Mirabel rubber dam documented that Chinook salmon annually begin to ascend the Russian River in late August or early September (SCWA 2005*b*). The peak of this run, which numbers 1,000 to 6,000 adult fish, occurs in late October or early November before river flows are naturally augmented by seasonal precipitation and runoff. A substantial component of this Chinook run enters Dry Creek. Late summer and early fall flow releases from WSD provide favorable depths and velocities for the migration of adult salmon in Dry Creek up to WSD, and they provide ample, good quality spawning habitats for Chinook salmon in Dry Creek. The predominant water temperatures in upper Dry Creek during October and November are highly suitable (12-13°C) for Chinook salmon spawning (data from USGS gage 11465000). The Corps and SCWA (2004) report that under existing operations, average water temperatures in lower Dry Creek during October and November are 15.1 and 13.1°C, respectively. Given that the run peaks in late October or early November in the lower river, most Chinook salmon likely spawn during mid to late November when water temperatures are in the vicinity of 12 to 14°C , well below the reported upper temperature limit of 16°C at which Chinook salmon eggs experience 50% mortality (Alderdice and Velsen 1978).

3. Dry Creek - Effects on Anadromous Salmonids

Steelhead, coho salmon, and Chinook salmon all spawn in Dry Creek. Corps and SCWA (2004) report that flow conditions and temperatures are very stable in Dry Creek and suitable for spawning and incubation of these species regardless of the water supply condition. Observations by NMFS staff of numerous adult steelhead and Chinook salmon in Dry Creek during the respective spawning seasons support these findings (T. Daugherty, NMFS, personal communication, 2007). Likewise, the annual return of several thousand adult hatchery steelhead[48] to the Warm Springs Fish Hatchery at the base of WSD confirm that passage conditions for adult salmonids are favorable under historic flow management practices (Corps and SCWA 2004).

Although conditions will be favorable for spawning and migrations of both adults and smolt stages, growth and survival of juvenile salmonids will be minimal in Dry Creek because suitable and optimal quality habitats will be very limited. Upon hatching and emerging from their gravel nests, salmonid fry are weak swimmers that aggregate in shallow, low velocity areas (<10 cm/sec) along stream margins (Chapman and Bjornn 1969; Everest and Chapman 1972; Bjornn and Reiser 1991). As they grow, juvenile steelhead and Chinook salmon occupy deeper and swifter habitats (Everest and Chapman 1972; Bjornn and Reiser 1991); coho fry and juveniles occupy deeper habitats often associated with heavy instream cover (Quinn 2005). Salmonid fry that emerge from the gravels of Dry Creek will encounter limited suitable quality habitats in

[48] Return of adult hatchery steelhead and coho that are stocked in Dry Creek as hatchery reared smolts.

which to rear. In most streams that support steelhead and salmon, intraspecific and interspecific competition for limited preferred areas cause the downstream displacement of many juvenile salmonids (Chapman 1966; Quinn 2005). Because rearing habitat is very limited in Dry Creek, most fry that originate from in-river spawning will be displaced into the lower main stem Russian River where predators abound and average summer water temperatures, which typically exceed 23°C, are unsuitable for juvenile salmonids. Very few or none of the young-of-year steelhead or coho salmon that are displaced downstream out of Dry Creek during summer are likely to survive.

The proposed flow management plan for Dry Creek will also greatly reduce the potential value of Dry Creek as habitat for young-of-year and yearling steelhead and coho salmon that emigrate out of the tributaries of Dry Creek. Small seasonal streams provide spawning habitats for steelhead; however, as flows subside and disappear during summer months, fry that are not stranded are displaced downstream where they may find suitable rearing habitats (Erman and Leidy 1975; Erman and Hawthorne 1976). Perennial tributaries, such as Wine Creek, Pena Creek, Crane Creek, and Mill Creek, provide limited rearing habitat, and large numbers of juvenile steelhead and possibly juvenile coho salmon will emigrate downstream in search of suitable habitat. Under the proposed flow management plan for WSD, very few juvenile steelhead and coho salmon originating in tributaries of Dry Creek that emigrate to Dry Creek will find suitable habitat. Most will be displaced downstream into the lower Russian River over the course of the summer. Survival of these individuals will be minimal.

NMFS recognizes that stream-dwelling salmonid species are adapted to survive in variable flow regimes that include episodes with high flows providing limited habitat for juvenile fish (Bjornn and Reiser 1991; Tetzlaff *et al*. 2005; Scruton *et al*. 2003). Salmonids are adapted to variable flows in temperate climates with year-round rainfall, and they persist below hydropeaking hydroelectric power dams that periodically release high flows for a few hours (Heggenes 1988; Pert and Erman 1994; Bunt *et al.* 1999). Salmonids respond to periodic high flow events by seeking limited velocity refugia in pools and other sheltered areas (Heggenes 1988; Bunt *et al*. 1999). However, prolonged high flows with durations that substantially exceed typical, natural, rainfall-runoff events, confine rearing salmonids to limited sheltering microhabitats (pools, and other velocity refugia) for extended periods, thereby reducing the availability of suitable habitats where these fish are able to forage.[49] Such conditions will compress areas of suitable habitat for prolonged periods, with likely adverse effects on individual growth rates and the stream's carrying capacity for juvenile salmonids.

High flow events can have other adverse ecological effects that affect salmonids. For example, Flodmark *et al*. (2006) suggest that short-term pulses of high flow from hydropeaking operations may have only limited effects on salmonid growth and behavior, but that artificial flow fluctuations may have significant impacts to riverine benthic communities. Poff *et al*. (1997) argue that rivers should be managed to incorporate natural flow variability with five components of a natural flow regime (*i.e*., the natural magnitude, frequency, duration, timing, and rate of change). Given the Mediterranean climate in central, coastal California and the near absence of rainfall-runoff events in the Dry Creek Valley between late May and early October, it may be that any sudden increase in flow during summer months is unnatural, with consequences to Dry

[49] That reduction in suitable habitat was documented in the interagency habitat-flow study.

Creek's benthic community. However, short term pulses of high flow (*e.g.*, 120 to 150 cfs with natural recession limbs) for only one or two days per month may simulate natural run-off events similar to those in more northerly or eastern streams that support salmonids. Infrequent, modest changes that simulate natural runoff events would probably not cause significant displacement of salmonids, although the effects of short term increases of summer flow on the benthic community are uncertain. Yet such consideration of the effects of short term increases in summer flow in Dry Creek is probably moot, given that recent historic and proposed operations entail prolonged releases of flow exceeding 100 cfs for several weeks or more during summer months.

It is not possible to provide a precise estimate of the numbers of juvenile steelhead and coho salmon that will be lost as a result of the high sustained flows in Dry Creek, because of the complexities of salmonid behavior and the paucity of salmonid population data specific to Dry Creek. However, as described in Section V.A.3.c, Dry Creek has an average width of about 9.2 meters when flows range from about 45 to 90 cfs; therefore the 14 mile segment of Dry Creek below WSD has a wetted channel area of approximately 205,000 m^2. Average density of juvenile steelhead in good quality rearing habitat in coastal California streams is approximately 0.5 to 1.5 fish/m^2 (Lau 1984; Harvey and Nakamoto 1996; Smith 2007; NMFS unpublished data). The interagency flow habitat assessment study indicates that rearing habitats are very good for steelhead at flows in the vicinity of 45 cfs (*e.g.*, 60 to 80 percent of several study sites provided suitable rearing habitat for steelhead fry and roughly half the channel provided suitable rearing habitat for age 1+ juveniles), and it shows that the quality and quantity of rearing habitat is greatly diminished at flows of 130 cfs. If we assume that steelhead production in Dry Creek would approximate that seen in other good quality steelhead rearing habitats (*i.e.*, 0.5 to 1.5 fish/m^2), then the segment of Dry Creek below WSD has the potential to rear about 100,000 to 300,000 juvenile steelhead. The precise production of steelhead in Dry Creek under current flow management with sustained flows over 100 cfs for many weeks is not known. However given that almost all of the flow-habitat study sites had less than 25 percent suitable habitat for steelhead fry at 130 cfs and many provided less than 10 percent suitable habitat, it is reasonable to assume that flows of 130 cfs reduce available rearing habitat for steelhead fry to one-quarter or less. Non-quantitative observations during the flow-habitat study indicate that sustained flows higher than 130 cfs further diminish available rearing habitat for steelhead. Given that 1) Dry Creek supports substantial runs of adult CCC steelhead that were outplanted as hatchery smolts, 2) spawning habitat for this species is relatively abundant in Dry Creek 3) CCC steelhead successfully spawn in all of the major tributaries, 4) steelhead routinely migrate downstream from tributaries in response to intraspecific competition (Chapman 1966; Quinn 2005) and reduced summer flow (Erman and Leidy 1975; Erman and Hawthorne 1976), and 5) downstream migration of juvenile steelhead has been routinely documented in Mill Creek, a tributary of Dry Creek (RRCSCBP monitoring data), it is reasonable to assume that juvenile steelhead produced in Dry Creek and dropdowns of juveniles from this stream's tributaries would populate most or all of the suitable habitat in Dry Creek, if flows were in the vicinity of 45 cfs. With such changes, Dry Creek would quickly support production of about 100,000 to 300,000 juvenile steelhead. Based on an estimated reduction of about 75%, the proposed project's flow regime would reduce that production to roughly 25,000 to 75,000 juvenile steelhead (or fewer with sustained flows exceeding 130 cfs between spring and early fall).

With respect to coho salmon, the proposed summer flows and ongoing channel maintenance in Dry Creek will probably not directly cause the immediate loss of many tens of thousands of juvenile fish, because the numbers of adult coho salmon that return to the Dry Creek watershed are currently extremely low. For example, during the winter of 2007/2008 less than five adult coho salmon were documented returning to all RRCSCBP streams in the Russian River watershed. Nevertheless, some juvenile coho probably do enter Dry Creek, where rearing habitat for this species is poor due to high flows and limited velocity refugia and other forms of shelter. In 2006, monitoring efforts for the RRCSCBP captured 311 age 0+ coho salmon as they migrated downstream in lower Mill Creek. Many of those fish likely moved downstream into Dry Creek. Although it is not known with certainty that adult coho salmon routinely spawn in Dry Creek and its tributaries, we do know that wild smolts have been recently captured in Mill Creek (RRCSCBP monitoring data), that coho salmon were documented in the Wine/Grape Creek system during 1998 (DFG unpublished data), and that other adult salmonids spawn in Dry Creek. Given that coho salmon spawn in riffle habitats similar to steelhead and Chinook (with minor differences in gravel size and current velocity), it is likely that a few adult coho do continue to spawn in the Dry Creek watershed in some or all years. Given the uncertainty of the actual numbers of adult coho that might spawn in this watershed, we assume a conservatively low estimate that three adult female coho salmon are able to successfully spawn in the mainstem Dry Creek each year and that an additional three adult female coho do successfully spawn in one of the several tributaries entering Dry Creek downstream of WSD. The result of such a modest return to the Dry Creek watershed would result in the production of an estimated 1800 juvenile coho salmon produced through natural spawning in Dry Creek and an additional 180 juvenile coho that enter Dry Creek as the result of emigration from Dry Creek tributaries that support natural spawning of this species (Table 24). The near absence of rearing habitats for juvenile coho salmon due to the degradation of habitat through ongoing channel maintenance and sustained high flows greatly limits the survival of the few coho fry that are produced in Dry Creek or emigrate into it. Given the near absence of coho salmon in the watershed, the very limited low velocity refugia with abundant cover, and the paucity of population data, we assume that 90% of juvenile coho salmon produced in Dry Creek are prematurely displaced downstream into the Russian River or other inhospitable habitats. Moreover, the continuation of these conditions prohibits growth of the Dry Creek subpopulation of coho, despite the stream's highly favorable water temperatures for this species.

Table 24. Estimated average number of coho salmon reproduced and stocked annually in Dry Creek and its tributaries, and the estimated number of juvenile coho salmon displaced from Dry Creek as the result of ongoing habitat degradation due to project operations (channel maintenance and flow releases).

Stream	**No. adult females successfully spawning**	**Egg production (2000/female)** [1]	**Egg to fry survival (assume 30%)**[1]	**Fry and juveniles entering Dry Creek during first spring & summer**	**Estimated Fry and Juveniles displaced downstream from Dry Creek**
Dry Creek	3	6000	1800	1800	1539 (90%)
Dry Creek tribs (wild)	3	6000	1800	252 (14%)[2]	226 (90%)
Dry Creek tribs (stock)	--	--	--	1200[2]	1080 (90%)
Totals:	6	12,000	3600	3252	2845

[1]Sandercock (1991)
[2]RRCSBSP unpublished data

The loss of juvenile coho salmon and steelhead that are displaced from Dry Creek to the lower river will affect the numbers of returning adults to the river. Elevated river temperatures, the presence of predatory species, and lack of suitable habitat are likely to reduce the survival of juvenile salmonids displaced to the Russian River. However, the effects of downstream displacement of juvenile Chinook salmon due to dam operations is less clear given that 1) this population migrates to the marine environment during the first spring such that individuals avoid exposure to high summer water temperatures in the lower river, 2) our review of the status of CC Chinook salmon indicates that the Central Coast diversity stratum, in which the Russian River is the principal watershed, supports a relatively abundant population of Chinook salmon that has exhibited positive growth rate despite ongoing operations at the dam and the lower coastwide returns during fall 2007, 3) our analysis found that the rearing PCE for the Central Coast diversity stratum does not appear to be limiting the Russian River population, and 4) in the Russian River, the freshwater rearing of Chinook salmon takes place largely during the late winter and early spring when stream flows are relatively high and largely determined by unregulated inflow from the river's tributaries.

4. Russian River Main Stem - Effects on Habitat, including Critical Habitat

To understand the effects of SCWA's flow management at WSD and CVD on main stem flows during summer and early fall, we began by examining USGS stream gauge records for the upper and lower Russian River before and after construction of the dams and after implementation of D1610. Table 25 shows the median daily flow in the Russian River at Hopland for the period July 1 through September 30 during representative years before and after construction of CVD. None of the years included in Table 25 represent periods with natural, unregulated flow, because

they all occurred after the construction of the PVP with its interbasin transfer of water from the Eel River, which has been ongoing since 1908. USGS records show that during the period 1947 to 1958, late summer diversions at Potter Valley into the Russian River generally ranged from about 200 to 300 cfs; whereas prior to the construction of Lake Pillsbury in 1922, diversions at the PVP in late summer were typically less than 50 cfs. USGS data also show that prior to the completion of Lake Pillsbury, Russian River flow immediately below the mouth of the East Fork at Ukiah was also usually less than about 50 cfs in July and less than 25 cfs in August and September.

Table 25 shows that in the 12 years immediately prior to the filling of Lake Mendocino in November 1958, median flow at Hopland for the period July 1 through September 30 generally ranged from about 110 to 225 cfs. After construction of Lake Mendocino but before adoption of D1610, summer flows increased in the upper Russian River, with median flows during the period July through September generally ranging from about 230 to 325 at Hopland. In many years the median flow at this location was over 250 cfs. After adoption of D1610 in 1986, median flow at Hopland during the three summer months was reduced and generally in the range of about 160 to 225 cfs. During this latter period, the lowest median summer flows at Hopland were 130 and 142 cfs, which occurred during the relatively dry years of 1988 and 2002, respectively.

Table 25. Median daily flow (cfs) in the Russian River during summer months (July 1-September 30) at the USGS Gage (No. 11462500) at Hopland during representative years before and after construction and storage at Lake Mendocino.

	Years Prior to Lake Mendocino					
Year:	**1947**	**1948**	**1949**	**1950**	**1951**	**1952**
Median daily flow[1]:	105	168	129	116	129	224
Year:	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**
Median daily flow:	249	183	183	189	174	197
	Years with Lake Mendocino Storage, PRE-D1610					
Year:	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**
Median daily flow:	244	237	280	243	260	253
Year:	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**
Median daily flow:	250	248	264	327	247	229
	Years with Lake Mendocino Storage, after adoption of D1610					
Year:	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
Median daily flow:	130	234	190	173	215	223
Year:	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Median daily flow:	162	208	227	208	221	259
Year:	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Median daily flow:	228	142	180	214	204	209

[1]Median daily flow is the median value of the mean daily flow during the period July 1-Sept 30 for that year.

At Guerneville, median flow during the period July 1 through September 30 was generally in the range of about 110 to 225 cfs prior to the construction of Lake Mendocino and Lake Sonoma (Table 26). In some years such as 1947, the median flow during the summer months was as low as 82 cfs. After the construction of the two major reservoirs, but before adoption of D1610, median flow for the period July 1 through September 30 was generally in the range of 170 to 250 cfs. Now with D1610, median flow over the three summer months is generally in the range of about 150 to 200 cfs in normal years. Under SWRCB procedures for designating dry years, flows were lowered such that the median flow at Guerneville for the three summer months was 113 and 120 cfs during 2001 and 2004, respectively.

Table 26. Median daily flow (cfs) in the Russian River during summer months (July 1-September 30) at the USGS Gage (No. 11467000) at Guerneville during representative years before and after construction and storage at Lake Sonoma and Lake Mendocino.

	Years Prior to Lake Mendocino and Lake Sonoma					
Year:	**1947**	**1948**	**1949**	**1950**	**1951**	**1952**
Median daily flow[1]:	82	158	109	110	131	224
Year:	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**
Median daily flow:	253	152	157	165	150	193
	Years with Lake Mendocino Storage, Pre-Lake Sonoma and Pre-D1610					
Year:	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**
Median daily flow:	227	179	252	177	191	187
Year:	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**
Median daily flow:	174	173	201	248	186	141
	Years with Lake Sonoma and Lake Mendocino Storage, after adoption of D1610					
Year:	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
Median daily flow:	146	191	163	141	187	224
Year:	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Median daily flow:	139	205	187	181	265	204
Year:	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Median daily flow:	187	113	149	208	120	191

Although the diversions at Potter Valley substantially augmented flows in the Russian River prior to the construction of CVD and WSD, SCWA is able to regulate the release of inflow from the Potter Valley project through storage and controlled releases from Lake Mendocino. The ability of SCWA to manage inflow from the Potter Valley diversion is demonstrated by SCWA's low flow proposal described by Corps and SCWA (2004). That plan calls for substantial reduction in main stem flows both in the upper and lower main stem. For example, SCWA's low flow proposal planned to reduce minimum flow requirements at Healdsburg and Guerneville to 50 and 35 cfs, respectively, during summer months in normal water years.

For the project considered in this opinion, SCWA proposes to manage the water supplies in Lake Mendocino and Lake Sonoma in a manner similar to recent past practices. This plan will continue to affect the following PCEs of critical habitat in the main stem Russian River: 1) freshwater rearing of steelhead and Chinook salmon, 2) estuarine rearing, 3) adult migratory habitat of Chinook salmon, and 4) spawning habitat of Chinook salmon. PCEs for migration and spawning of steelhead should not be affected by SCWA flow management, because adult steelhead migrate and spawn during the winter months and early spring when CVD and WSD are

managed by the Corps for flood control and SCWA diversions for water supply are satisfied by natural flow in the Russian River. Likewise, PCEs of critical habitat for the migration and spawning of coho salmon in the main stem will likely not be affected by releases for water supply because this species typically migrates and spawns from November through January, when flows are naturally elevated and under the control of the Corps for flood protection. The absence of observations of coho salmon at the continuously monitored fish ladder at the seasonal Mirabel rubber dam (SCWA 2005*b*) suggests that, unlike other salmonid species, adult coho salmon do not ascend the Russian River until at least after seasonal rains increase flows in the Russian River and the Mirabel dam is deflated. The main stem Russian River does not support rearing habitat for coho salmon during summer months because its water temperatures far exceed suitable temperatures for coho salmon (Corps and SCWA 2004).

SCWA's proposed management of water supply will likely have little adverse affect on the quality of rearing habitats for salmonids in the Russian River main stem between Cloverdale and Monte Rio, because in that segment, summer water temperatures typically exceed thermal tolerances of rearing salmonids (Corps and SCWA 2004). Thus this segment provides both minimal amounts and marginal quality rearing habitats for these species.

SCWA's proposed flow management will continue to influence the quality of PCEs of critical habitat for rearing of steelhead and Chinook salmon in the 34 mile segment of the upper Russian River between Cloverdale and CVD. Whether these influences are benign or adverse partly depends on the water year type as classified by D1610. During the past fifteen years SCWA has usually sustained releases from CVD of more than 250 cfs for many weeks or months during the summer (see baseline section V.C.1). Each of these were normal water years, except for 2001, a dry year, when median monthly flows during July, August and September ranged from 184 to 199 cfs. The interagency flow-habitat assessment study, described above, found a clear negative relationship between flow and availability of rearing habitat for steelhead and Chinook salmon in the upper Russian River. Much of this segment provides suitable quality rearing habitat for steelhead and Chinook salmon at a release of 125 cfs from CVD; whereas the highest observed study flow (275 cfs) creates conditions providing substantially lower amounts of rearing habitats for these species (Table 23). This was especially true for the fry stage.

The principal factor governing this flow-habitat relationship for rearing steelhead and Chinook salmon is the current velocities that increase with flow and eventually exceed the tolerances of these juvenile life stages. SCWA's plan to maintain status quo operations at CVD during the low flow season will likely provide less suitable and optimal quality habitats for rearing steelhead and Chinook salmon, especially during "normal years", compared to the amounts that would be available with lower flow releases. High flows associated with operations during normal water years will create high current velocities that will limit available habitat. During dry years and critically dry years, SCWA is able to reduce releases from CVD relative to normal years, as the result of D1610 provisions. Reductions in flow would reduce in-channel velocities that limit habitat quality. However, past operations during a dry year (2001) suggest that despite the reduction of the minimum flow requirement at Healdsburg from 185 cfs (the normal year minimum) to 75 cfs in dry years, CVD continues to release close to 200 cfs during dry water years - a reduction of about 50 to 75 cfs from typical releases in normal years.

Waters released from Lake Mendocino are relatively cold during summer months. However, as the cold water pool becomes depleted, the waters released from the CVD become warmer as the summer progresses. Under current practices, median monthly water temperatures immediately downstream from CVD were 12.7, 15.1, and 19.4°C in July, August and September, respectively (data from USGS Gage 11462000). Summer water temperatures remain suitable for steelhead rearing as far downstream as Cloverdale, where average daily water temperatures are in the vicinity of 20°C in late August and September (Corps and SCWA 2004).

In contrast to the effects on rearing habitat, the proposal to manage main stem flows in a manner similar to recent operations will likely provide good quality conditions and habitats for the adult migration and spawning of Chinook salmon. During late summer and early fall, in compliance with D1610, project releases from CVD and WSD provide depths and velocities in the main stem that facilitate the upstream migration of adult Chinook salmon to CVD and the West Branch Russian River. The artificially high flows in the lower Russian River also ensure that the mouth of the river is open, thereby allowing the annual entry of fall run Chinook salmon during the late summer and early fall. Proposed flow releases from CVD will also provide abundant, good quality spawning habitats for Chinook salmon in the upper main stem during October and early November, the period when most adult Chinook move upstream past the Mirabel rubber dam (SCWA 2005*b*). The predominant water temperature in the upper Russian River during November (14°C) is suitable for Chinook salmon spawning (Healy 1991).

5. Russian River Main Stem - Effects on Anadromous Salmonids

The principal anadromous salmonid life stages to be affected by SCWA's proposed water supply management plan for the Russian River main stem are the adult migratory and spawning stages of Chinook salmon and rearing juvenile steelhead. As stated above, the SCWA flow management plan should have little effect on steelhead and coho salmon migrations or spawning because these life stages occur during late fall and winter when flow operations are managed for flood operations and main stem stream flows are largely determined by precipitation and natural runoff. We have considered the possibility that the artificially high flows sustained in the lower river during fall months due to releases from Lake Mendocino may have some potential to affect adult coho, if returning adult fish enter the Russian River before winter rains elevate flows in the river's tributaries where most spawning habitat occurs. Any adults that might be prematurely attracted into the Russian River by the artificially high flows in the lower river during early to mid fall would be exposed to detrimentally high temperatures in the main stem. However, we believe that the incidence of such occurrences will likely be very limited and of minor consequence to the coho population given that 1) CCC coho salmon historically enter rivers, migrate and spawn during December and January after water temperatures have declined, 2) Sandercock (1991) reports that adult coho salmon mill about the mouths of rivers until both water temperatures and flow are suitable for upstream migration, 3) adult coho have not been documented in the lower main stem during six years of continuous video monitoring at the Mirabel Dam, 4) we are unaware of any reported stranded adult coho in the main stem during early to mid fall, and 5) CCC coho salmon runs in the Russian River were relatively robust prior to 1960, yet artificially high flows during fall months have been ongoing in the lower river since completion of Lake Pillsbury in 1922.

Under SCWA's proposed flow management plan, in most years the mouth of the Russian River will be open on most days in September and October. These are months when the river mouth and estuary were probably closed prior to the construction of Lake Pillsbury and Lake Mendocino. The following section describes the effects of flow management on the estuary, including salmonid use of that estuary. However, in addition to those considerations, the artificially elevated flows in the Russian River will continue to provide conditions that promote adult Chinook salmon access to the lower river. As a result, this species will very likely continue to commence its annual run during late summer or early fall, with run peaks sometime in late October or early November. The elevated flows produced by releases at CVD will continue to create substantial amounts of spawning habitat that will contribute to the production of Chinook salmon smolts. SCWA (2005*b*) estimated that during the peak of the downstream run in 2004 (mid April through late May), 90,000 wild Chinook salmon smolts passed the Mirabel rubber dam. Based on trap data, numbers of Chinook smolts were likely comparable or higher in 2002 and 2003 (SCWA 2005*b*). Probably most of these fish originated from adults spawning in the upper main stem Russian River. Under the proposed flow management plan, this level of production will likely continue.

With the proposed flow management plan, the upper main stem Russian River will continue to support some production of juvenile steelhead and Chinook salmon. SCWA (2003) reported observing relatively low numbers of steelhead in the approximately 20.5 mile segment between the mouth of the East Fork and Hopland. They found higher densities of juvenile steelhead in the 13.0 mile "Canyon Reach" between Hopland and Cloverdale. At the time of that study, releases from CVD were usually between 230 and 270 cfs and flows at Hopland were about 165 to 190 cfs. The interagency flow habitat assessment study and water temperature modeling suggest that the quality and quantity of habitat for rearing steelhead is substantially better when releases are in the vicinity of 125 cfs and flow at Hopland is about 90 cfs.[50] Under the proposed flow management plan, steelhead fry that emerge from the gravels of the main stem Russian River will encounter limited suitable habitats in which to rear. As described above for Dry Creek, juvenile steelhead will compete for the limited preferred areas as they grow, with many individuals being displaced to marginal or unsuitable habitats where survival will be much reduced.

The proposed flow management plan will also limit the potential quantity and quality of the upper main stem as critical habitat for young-of-year and yearling steelhead that emigrate out of the river's tributaries in Mendocino County. Small seasonal streams provide spawning habitats for steelhead; however, as surface flows subside and disappear during summer months some fry will be displaced downstream where they must find suitable rearing habitats (Erman and Leidy 1975; Erman and Hawthorne 1976). Perennial tributaries, such as Mill Creek, Sulfur Creek, Forsythe Creek, Ackerman Creek, and McNab Creek also provide limited rearing habitat, and large numbers of juvenile steelhead will likely emigrate downstream in search of suitable habitat. Under the proposed flow management plan for CVD, many juvenile steelhead originating in tributaries of the upper main stem will be displaced downstream into the Russian River over the

[50] The discrepancy in the difference in flow between CVD and Hopland during the two studies is due to the higher total diversion of water from the main stem during the steelhead survey in August and early September 2002. The flow-habitat assessment study was conducted in late September 2001 when agricultural water demands are less.

course of the summer. Survival of these individuals will be low, due to limited availability of suitable rearing habitats in the main stem.

Juvenile Chinook salmon typically migrate towards the ocean within months of their hatching and emergence from the gravel. The peak of the juvenile Chinook salmon out-migration is usually in late April or early May (SCWA 2005*a*), and almost all individuals that successfully make it to the estuary do so by late June. SCWA's proposed flow management operations will probably have only a modest effect on juvenile Chinook salmon during February, March and April because stream flows in the upper main stem during these months are heavily influenced by natural inflow from numerous tributaries. For example, between 1987 (the year D1610 was first implemented) and 2005, the median flow in April 500 ft downstream from CVD (USGS station 11462000) was 207 cfs; whereas median flow in April at Hopland and Healdsburg during those years was 360 and 664 cfs, respectively. The flow management plan will have a greater effect on juvenile Chinook salmon rearing in the main stem during May when releases from CVD largely determine stream flows. For example between 1987 and 2005, the median flow immediately below CVD in May was 191 cfs; whereas median flow at Hopland in May was 230 cfs during this same period of years. Similar to the flow-related impacts to juvenile steelhead, production of juvenile Chinook salmon would likely be higher if flows in the upper main stem were reduced from recent historic levels (*i.e.*, releases of approximately 230 to 275 cfs at CVD) to releases in the vicinity of about 125 to 175 cfs.

However, as discussed for Dry Creek, effects of downstream displacement of juvenile Chinook salmon due to dam operations is less clear given that 1) the species migrates to the marine environment during the first spring thereby avoiding exposure to high summer water temperatures in the lower river, 2) the ESU's Central Coast diversity stratum supports a relatively abundant population, despite ongoing operations at the dam, 3) the rearing PCE for the Central Coast diversity stratum does not appear to be limiting the Russian River population, and 4) for this population, freshwater rearing takes place largely during the late winter and early spring when stream flows are relatively high and largely determined by unregulated inflow from the river's tributaries.

G. Estuary Management

The analysis described below incorporates and supersedes the previous analysis reported in the May 20, 2005, biological opinion on breaching the bar at the mouth of the Russian River. Since that analysis, NMFS has acquired additional information on the frequency of breaching, as well as reports and data on estuarine conditions and salmonids in the Russian River estuary and other estuaries and lagoons in California. In addition, D1610 summer flows, which influence the frequency of SCWA's breaching estuary, are included as part of the proposed project analyzed in this consultation.

Information on the Russian River estuary, including the impacts of breaching on habitat and salmonids, remains limited. Studies of fish species and water quality in the estuary in the early 1990s were conducted in the first 5.5 miles of the estuary. In the late 1990s the same issues were studied in the lower three miles of the estuary (MSC, 1997 through 2000). More recent work (SCWA 2005a, 2006) included observations near the river's mouth and in the seven miles

upstream to Austin Creek. Most recently, SCWA has used acoustic tags to track small numbers of large juvenile steelhead in the estuary (SCWA 2006a). Where data are lacking, NMFS has made reasonable assumptions based on professional knowledge of salmonids and their habitat needs from the scientific literature, and best professional judgment.

NMFS cannot precisely predict the amount and timing of future SCWA breaching actions because surface water elevations in the estuary and storm conditions are variable throughout the winter, spring, and fall months.[51] In order to analyze the impacts of the proposed estuary breaching, NMFS assumes that breaching during the next fifteen years would occur at roughly the same frequency and times as in the recent past. Information on recent breaching indicates breaching actions as proposed by SCWA would typically be conducted mostly in the spring and fall, as shown in Table 27 below.

1. Effects on Habitat, Including Critical Habitat

a. Migration

Breaching changes the amount of time the estuary is open to ocean tides. As described above in the *Environmental Baseline* section, the Corps and SCWA's proposal to continue breaching the Russian River estuary bar as they have in the recent past will result in the estuary being open to ocean tides: 1) earlier in the fall of most years, 2) during nearly all summers, and 3) more often during the spring.

The primary impact on the migration PCE of critical habitat for all three salmonids species will be to increase its availability. Adult salmonids intending to migrate upstream in the late summer or fall are less likely to find their way blocked by a closed bar at the mouth of the Russian River. If breaching did not occur, the high flows in the mainstem during the fall would likely overtop the bar within 2-3 weeks of bar closure, opening the migration route. Similarly, smolts outmigrating in the spring will have more opportunity to enter the open ocean when they arrive in the estuary. Keeping the estuary open in the summer affects the rearing PCE of critical habitat for listed salmonids; this impact will be discussed in *b. Estuarine Rearing* below.

Breaching likely increases the number of pinnipeds in the estuary, but the amount of increase in predation on salmonid adults appears discountable. Harbor seals (*Phoca vitulina)* have been documented foraging in the surf zone outside of the Russian River estuary and inside the estuary (RREITF 1994). RREITF (1994) reports that more harbor seals are in and near the estuary when it is open, based on seal haul-out numbers. Observations during a five-year monitoring period showed that the number of pinnipeds quickly increased once the sandbar was artificially breached. Few, if any, adult salmonid remains have been found in seal scat (Hanson 1993). Most predation is assumed to occur to smolts and juveniles. The amount of predation on smolts and juveniles is described below in subsection VI.G.2, Effects on Species.

[51] In wet years, stream flow to the estuary remains high into June. In dry years, stream flow may recede to D1610 regulated flows by April 1st.

b. Estuarine Rearing

Coastal estuaries of California can have complex water quality dynamics during the extended period of seasonal low flows. In many rivers, the absence of rainfall during summer and early fall generally sets up conditions favoring the formation of highly productive freshwater lagoons. Keeping the estuary open to the ocean tides by breaching will severely restrict the quantity of rearing habitat for salmonid juveniles seeking productive freshwater conditions. A freshwater lens will not be able to persist and a freshwater lagoon will have no chance of forming. This loss of freshwater habitat likely limits the carrying capacity of the estuary for juvenile salmonid rearing. In addition, every time the estuary is breached, it will be cycled through adverse changes in water quality for salmonid rearing. Pinniped predation on salmonids may also increase.

When the sandbar at the mouth of the estuary closes, river flows from upstream accumulate over the remaining denser salt water in the estuary, forming a thick freshwater lens at the surface. Breaching the bar removes this accumulation of freshwater by allowing it to flow to the ocean. Because breaching usually occurs within 10 days[52] of bar closure, newly formed freshwater lenses are unlikely to be more than one to three meters deep before they are lost. Once the freshwater lens is lost, the estuary cannot become a freshwater lagoon. Conversion to freshwater by gradual deepening of the freshwater lens (and the eventual passage of denser salt water through the sand bar to the ocean) appears to require one month or longer in other California streams (Smith 1990). The formation of a perched lagoon is also prevented by breaching. In this process (described above in the *Historical Conditions* section of the ***Environmental Baseline***), freshwater inflow raises the estuary's surface water elevation until the bar is overtopped. Freshwater running out to the ocean over the bar entrains and eventually removes most of the salt water in the lagoon. With the bar intact, ocean tides cannot refill the estuary with salt water.

Without conversion to a freshwater lagoon, food production for young (YOY and parr) juvenile steelhead[53] may be limited. Conversely, Smith (1990) found that the diversity and quantity of salmonid foods were high after closed lagoons converted to freshwater. In addition to euryhaline (tolerant of a wide range of salinities) species of amphipods present under a wide range of estuarine conditions, freshwater insects and other invertebrates also become abundant when lagoons convert to freshwater (Smith 1990). NMFS recognizes that forage base in the vicinity of the estuary is dependent on both water quality dynamics (*e.g.*, salinity, DO, temperature, nutrients) as well as suitable, stable substrates, and that sedimentation of substrates in freshwater lagoons may limit aquatic productivity.

In addition to the potential for reduced food production, salinities in much of the estuary are beyond the tolerable range for smaller age classes of non-smolting juvenile steelhead when the

[52] From 1996 to 2000, the estuary closed 42 times and was breached 40 times within 10 days after it closed. NMFS assumes this timing of breaching actions will continue.

[53] NMFS focuses on juvenile (non-smolting) steelhead habitat in this section because impacts to steelhead habitat are of greater magnitude than impacts to juvenile habitat for coho salmon or Chinook salmon.

estuary is open during the late spring, summer, and fall[54] (as described in the *Status of the Species*). In addition, seasonal cycles of breaching followed by closures contribute to periodic episodes of low DO in the deeper salt water layers that may turn to anoxic or near anoxic conditions. Because the estuary is breached relatively quickly, low DO at depth likely persists until the bar is opened. Whereas if the estuary were managed as a closed or perched lagoon with sufficient inflow, the lower Russian River could form a productive freshwater lagoon with suitable water quality to sustain large numbers of young juvenile steelhead during the summer and fall.

NMFS review of recent SCWA data on water quality in the estuary (SCWA 2004b, and 2005a, 2006a, 2006b, 2008e) indicates that when the estuary is open, the most upstream portion of the estuary near Austin Creek[55] (about 1 mile of the upper estuary) is the only portion where some freshwater habitat is maintained throughout the summer. Salinity in this area remains at zero to a depth of 2 meters and possibly deeper, depending upon tidal fluctuation[56]. The middle portion of the estuary (1 to five miles from the mouth) is most subject to fluctuation in salinities throughout the water column due to ocean tides (SCWA 2004b). Here, salinities are often as high as 30 ppt. Salinities near the mouth (1st mile of the estuary) are mostly similar to ocean salinities (SCWA 2004b, 2008e). Salinities only fluctuate at the surface in the lower portion of the estuary based on tidal action (SCWA 2006a, 2008e). For example, near the mouth, salinities are about 30ppt[57], except near the top of the water column (approximately 1 meter from the surface), where they fluctuate between about 1 ppt and 33 ppt (SCWA 2006a, 2008e).

When the bar is open, DO also fluctuates based on tidal action in the estuary. DO is reported to be approximately 7 -10 ppm in the surface layers, and varies, on average, from 4 to 9 ppm in bottom areas of estuary pools (SCWA 2004b, 2006a, 2008e). Short excursions to 0 ppm or near 0 can occur, mostly in deep pools (SCWA 2006a, 2008e). Similar to salinity above, DO at pools in the vicinity of Austin Creek did not go as low as 4 ppm; instead, DO ranged from 6 to 11 ppm. Near Freezout Creek, about 1 mile downstream from Austin Creek, DO at depth usually ranged from 7 -10 ppm. However, brief excursions to lower than 1 ppm occurred in 2006 (SCWA 2008e). Estuary temperature during bar-open conditions ranged from about 11°C to 15.5^{o}C in late summer and early fall in pools where it was measured during 2003 (SCWA 2004b). During the same time period and conditions in 2005, temperatures in the lower estuary ranged from

[54] NMFS is not further analyzing breaching impacts to rearing habitat during the winter because: 1) breaching in the winter is very limited in frequency, and 2) winter breaching is more likely to mimic natural habitat conditions. Breaching occurs mainly in the spring and fall, although occasionally SCWA has breached the estuary in the summer, and more rarely, in the winter (Table 23). If the estuary does close during the winter, winter storms are likely to reopen the bar before a freshwater lagoon can form.

[55] Recently, SCWA has decided to redefine the extent of the estuary to exclude the mouth of Austin Creek (SCWA 2008a), due to their failure to detect seawater or brackish water in this area. NMFS has chosen to continue to include the area of the Russian River at the mouth of Austin Creek as part of the Russian River estuary in this biological opinion. NMFS does this to include data that show more abundant small age classes of juvenile steelhead in freshwater conditions.

[56] In the estuary breaching opinion (May 20, 2005) NMFS indicated that: "Salinities were <5 ppt throughout the water column in the upstream areas of the estuary". This statement was in error, and should have read "salinities *averaged* less than 5 ppt in the upper 2 miles of the estuary". The data available indicate that although the upper 2 miles average less than 5 ppt, excursions to salinities of about 20 ppt can occur outside of the area immediately adjacent to Austin Creek.

[57] Ocean salinity is 35 ppt.

about 12.5 ^{o}C at the bottom to 20 ^{o}C at the surface (SCWA 2006a, 2006b). In 2006, temperatures during open bar conditions ranged from highs of over 25 ^{o}C for short periods to lows of 16 ^{o}C at the surface (SCWA 2008e), depending on time of year (high temperatures were in late July, low temperatures were in early October). At mid and bottom depths, temperatures ranged from 10 ^{o}C to 18 ^{o}C during roughly the same time periods (SCWA 2008e). Interestingly, the highest surface temperatures appear correlated with the lowest temperatures at depth at many locations.

When the bar at the mouth of the estuary closes, water quality for salmonids quickly degrades. Salinity, DO and temperature changes can begin within 24 hours (SCWA 2006a, 2006b). During these events, tidal action ceases and salinity, DO and temperature can change dramatically. A freshwater lens begins to form at the surface, starting at the mouth and then extending approximately 4 miles upstream. During one bar closure in 2003, salinity at the surface varied from 1 to 5 ppt in the lower four miles of the estuary, and was 0 ppt from 4 to 7 miles upstream of the mouth (SCWA 2004b). Similar values were obtained in 2005 (SCWA 2006). Salinity in the deeper layers of the estuary ranged from 25 to 30 ppt (SCWA 2001a). Recent data (SCWA 2008e) indicates that the estuary may become more saline at depth in upper areas of the estuary (near Freezout Creek) when the bar closes. After sandbar formation, saline bottom waters in estuaries often initially become anoxic because of a lack of mixing (Smith 1990). Based on the salinity and water quality data available, this is likely what occurs in many of the deeper pool areas of the Russian River estuary. When the bar closes, DO concentrations near the surface remain similar to those found when the estuary is open (7 to 10 parts per million (ppm)). In deeper pools, DO typically drops to less than 5 ppm (SCWA 2001a, SCWA 2006a, 2008e). These hyper-saline and low DO conditions limit salmonid juvenile rearing habitat to the upper 1 to 3 meters of the estuary in most cases.

Low DO and hyper-saline conditions that occur in the bottom layers of the estuary when it closes are also likely to initially reduce the availability of food for rearing juvenile salmonids in the estuary. In lagoons north and south of the Russian River, temporary loss of estuarine invertebrates (salmonid food) was documented (or inferred by steelhead growth rates) each time lagoons closed (Corps and SCWA 2004; Cannata 1998; Smith 1990).[58] Reduced steelhead growth has been documented in stratified California coastal lagoons, both north and south of the Russian River (Corps and SCWA 2004; Smith 1990). In the Navarro River, a California coastal lagoon/estuary north of the Russian River, the closure of the sandbar appeared to result in a temporary reduction in steelhead growth and/or caused movement to middle and upper lagoon areas where habitat conditions were better (lower salinity). Although the lagoon did not convert to freshwater, as freshwater accumulated growth rates rebounded and appeared to slightly exceed growth rates prior to lagoon formation (Cannata 1998).

[58] Estuarine invertebrates increased when the lagoons transitioned to fresh water.

Table 27. Breaching of the Russian River Estuary, 1996-2007. Number of times breached by year and month, including breaches by SCWA, natural breaches (denoted by [#]), and breaches conducted by private individuals without a Corps permit, denoted by (#). Data from Corps and SCWA 2004, SCWA 2002-2004, SCWA 2006-2008).

	YEAR											
MONTH	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
January						1						
February												1,[1]
March		1										
April		[1]				2			[1]			3
May		1, [1]			1	3			1			
June		2		1	1		1	[1]				
July	1			1								
August	(2)	1							[1]			
September	1, (1)	2	4	1	1					1		
October	1	1	3	2	2	2	[1]	2	(1)	1	[1]	[1]
November	[1]	1	1	1, [1]	4	[1]	3		(2)	2	[3]	2
December					2		1	1			[1]	[1],1
Totals	7	11	8	7	11	9	6	4	6	4	4	10
SCWA	3	9	8	6	11	8	5	3	1	4	0	7
breached/ open*	6/1/96	6/26/97	6/1/98	7/1/99	6/21/00	6/1/01	6/4/02	6/12/03	8/6/04	6/1/05	6/01/06	6/01/07
Closed	6/29/96	8/9/97	8/26/98	9/17/99	8/28/00	9/25/01	9/30/02	10/8/03	10/10/04	9/16/05	10/23/06	10/22/07
Total days open in summer	28	44	86	78	68	116	118	118	65	107	145	144

*June 1 used if estuary was open in the spring- numbers are meant to reflect the approximate total number of days the estuary was open continuously in the summer

Although temperatures may increase in the summer and late fall when the bar is closed, the temperatures observed remained within tolerable limits for juvenile steelhead[59] during the short closure periods (1-3 weeks) for which data are available. Bar-closed temperatures at depth and at the surface appear to increase in most cases in comparison to temperatures at the same depths and location during bar-open conditions (SCWA 2004b, 2006a, 2008e). Bar-closed water surface temperatures monitored in the estuary by SCWA in 2003 varied between 16.5^{o}C and 18°C (SCWA 2004b). In 2005, surface water temperatures during bar closure varied between 19.4 ^{o}C and 23.9 ^{o}C (SCWA 2006a)[60]. These higher temperatures can be tolerated by steelhead if food supplies are abundant and the highest temperatures are not constant (Spina 2007). For example, although steelhead showed lower growth in 1997 in the Navarro Lagoon when temperatures at the surface and depth exceeded 24°C for 2-3 weeks (Canata 1998), steelhead numbers at the end of the summer in 1997 were roughly equivalent to numbers in 1996 when temperatures were lower.

Whenever the bar is breached, the freshwater surface layer (1 to 3 meters in depth) of the lower four miles of the estuary will run into the ocean as the elevation of the estuary's surface decreases. Breaching typically occurs when the estuary reaches a depth of 7 feet or greater. After breaching, the water surface elevation of the estuary is typically 2 feet. Tidal action returns salinity, DO, and temperature to conditions found in the open estuary.

Multiple breaching events cycle the Russian River estuary through episodes of poor water quality. Multiple breaching is common and is expected to continue through the next fifteen years as part of the proposed project. The estuary is likely to be breached by SCWA twice as often in the fall than the spring. During the years 1996-2007 the estuary was breached by SCWA an average of about two times from January through July and about four times from August through December.

2. Effect on Species

a. Chinook Adult Migrants.

Breaching in the late summer and fall as proposed is likely to benefit some early migrating adult Chinook salmon in the Russian River, although early migrants (August and September) may be more vulnerable to sport fishing. Opening the bar during the late summer and fall allows adult Chinook salmon additional opportunities to access the Russian River, although the estuary is often open to the ocean in August and September, likely due to spring breaching combined with ocean conditions and high summer flows. During October and November, the bar often closes, but high river flows would likely reopen the bar in a few weeks as described above in the ***Environmental Baseline***). Currently, thousands of Chinook salmon enter the Russian river in October and November, when breaching by SCWA is most active[61] (25).

[59] Juvenile coho salmon and Chinook salmon are discussed below.
[60] In 2006, the bar did not close during the hottest months of the year and temperatures were lower (SCWA 2008e).
[61] NMFS doubts that breaching the bar is the only factor responsible for the recent increase in Chinook salmon numbers based on the available data. As reported in the *Environmental Baseline*, the number of Chinook salmon spawners in the Russian River, and the number of Chinook migrating upstream has increased during the monitoring

Early arriving (August - September) adult Chinook salmon may be more susceptible to sport fishing anglers due to the extended period of time that they spend in the river. NMFS staff have observed members of the public hooking and releasing adult Chinook salmon throughout the Russian River, even though recreational angling for this species is prohibited by Federal law (67 FR 1116). Most of these fish are likely those that have entered the system early and are thus more easily targeted by sport anglers because late summer and fall flows are lower and less turbid than flows after winter rains begin. During the months of August and September for the years 2000 to 2005, adult Chinook salmon counts at the Mirabel monitoring site ranged from approximately 15 to over 1,000 adult salmon (SCWA 2006*b*). The number of Chinook salmon that are caught by in-river sport anglers during August and September is not known. However, the Joint Chinook Technical Committee of the Pacific Salmon Commission estimates a 12% mortality of adult Chinook salmon caught in hook-and-release recreational fisheries (CTC 1997).

The number of anglers catching Chinook salmon during late summer and early fall has likely been reduced by recent Sonoma County law enforcement efforts (Press Democrat 2006).

b. Coho Salmon Adult Migrants

Breaching as proposed may harm early coho salmon adult migrants by allowing them access to the Russian River watershed when conditions are poor for tributary migration and spawning. CCC coho salmon are most likely to enter freshwater streams to spawn after fall or winter rain storms breach bars at estuary mouths. The bulk of coho salmon migrants enter rivers in California in November and December (SCWA 2005b). On more northern rivers in California with estuaries that are open to the ocean most or all of the year, SONCC coho salmon may enter in early October[62] (CDFG 2002). Maintaining the Russian River estuary open to the ocean by breaching for the last several decades may have allowed some CCC coho salmon migrants to adopt earlier river entry behavior.

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 known to presently, or historically, support coho salmon. For example, the mouth of Austin Creek is often dry in the late summer and early fall. The dry condition is likely the result of aggradation of the stream bed at the mouth caused by gravel mining and timber harvest in the Austin Creek watershed (D. Hines, NMFS, personal communication, 2006).

c. Steelhead Adult Migrants.

Early steelhead migrants (October) may experience impacts from the proposed breaching somewhat similar to the impacts NMFS expects for early coho salmon migrants. However, the

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period (the last five years) (SCWA 2005b). Breaching the estuary's bar has occurred at roughly the same frequency as proposed for several decades and cannot be solely responsible for the recent increase in upstream migrants.

[62] Coho salmon are known to enter the Klamath and Eel Rivers in October. In the Klamath, they may begin entering in early September (CDFG 2002).

proportion of early steelhead unable to find spawning areas is likely lower than for coho salmon, as steelhead migrate later in the fall and winter and often spawn in river mainstems. From 2000 to 2004, no more than nine steelhead were counted migrating in the Russian River in October (SCWA 2005b)[63]. These few steelhead would likely be able to spawn in the mainstem and Dry Creek, which contain flows all year. The bulk of steelhead migration and spawning is January to March, when the estuary would naturally be open in most years.

Late steelhead migrants and spawners returning to the ocean may benefit if breaching actions are concurrent with their arrival at the mouth of the Russian River. Steelhead may migrate as late as April in some years (Busby *et al.* 1996). The estuary can close as early as April, as evidenced by SCWA breaching in April or March in four years during 1996-2007. Spring breaching in these years may allow late steelhead migrants, if present, to avoid delay in their spawning run in the Russian River. As above, high summer flows would eventually overtop the bar and provide access. Unlike salmon, a small portion of steelhead can survive spawning. These fish return to the ocean and can spawn in subsequent years. Breaching in March, April, or May could assist these fish in avoiding delay in returning to the ocean[64]. Breaching in these months occurred in five years from 1996-2007.

d. Smolts

Breaching the estuary in the spring and early summer is unlikely to adversely affect salmonid smolts of each species and may benefit them by allowing greater access to the marine environment. Most of the potential benefit would accrue to smolts that are migrating downstream later in the spring (May and June), when breaching is most likely to occur (as shown in Table 27 above). Winter breaching is rare, and when it occurs, is likely to mimic natural environmental conditions to which smolts of all three species of salmonids are adapted. Because Chinook salmon smolts can use estuaries for extended periods of time, NMFS focused the analysis below on them.

Although their ocean-type life history suggests Chinook salmon can use estuaries for extended periods of time to rear (Busby *et al.* 1997), the information available indicates their use of the Russian River estuary is limited (RREITF 1994, SCWA 2001a). To date, the monitoring work done by RREITF during 1992 and 1993, MSC from 1996 to 2000, and SCWA in 2003, 2004, and 2005 shows that only very few juvenile Chinook in the Russian River estuary maintain residency through much of the summer (SCWA 2004a, SCWA 2001a, RREITF 1994, SCWA 2005a). For example, 106 were captured via seining in 2005, with most captures occurring prior to the end of June (SCWA 2006a).

The short residence time for Chinook salmon in the Russian River estuary may be attributed to the size of these juvenile fish upon entering the estuary. According to Healy (1991), in general, Chinook salmon fry remain in the estuarine nursery areas until they are 70 mm fork length, and

[63] No coho salmon were observed in the Mirabel fish ladders during this period. However, the dam is upstream of several tributaries where coho salmon are likely to spawn, such as Austin Creek. These coho would not encounter the dam on their spawning migration.

[64] Steelhead spawning can occur as late as May (Busby 1996).

then disperse into nearby marine areas. Juvenile Chinook salmon passing the Mirabel site in the Russian River (River Mile 21.5) averaged 74 mm by the third week of April, and averaged 105 mm by the last week of June (SCWA 2004a). Nine juvenile Chinook found in early June by RREITF (1994) in the estuary averaged 114 mm in length, which suggests they were of sufficient size to enter the marine environment.

More recent data confirms the large size of Chinook salmon in the estuary, but also suggests that more may rear through part of the summer than indicated by previous studies. About 340 juvenile Chinook salmon were captured in the estuary in 2007 (Fuller 2008b). Nearly all captures occurred between May and July, only 11 Chinook salmon were caught in August. NMFS' inspection of the data indicates that the size of Chinook salmon caught appeared to increase each month (average size roughly 85 mm in May, 91 mm in June, 106mm in July, and 117 mm in August). This may indicate Chinook rearing in the estuary until the end of August, after which no captures occurred.

Breaches in the late winter or early spring may be of more concern due to the smaller size of Chinook salmon juveniles that may be present. These breaches are few, only two occurred prior to April during the twelve year period described above. In the winter and early spring of most years, the estuary would likely be open to the ocean, and downstream Chinook salmon migrants would likely have evolved and adapted to such conditions[65].

The increased numbers of seals as a result of estuary breaching (described above in 1. Effects on Habitat, Including Critical Habitat, a. *Migration*) appears to increase the number of smolts and juvenile salmonids that are eaten by seals, although the overall predation rate remains low. Each time the estuary is breached, pinniped haul-out attendance increases from about 15 to about 95 seals (Mortensen 1996). However, Hanson (1993) reports that juvenile/smolt salmonid remains found in seal scat on the sandbar at the mouth increase in frequency when the mouth is closed.

e. Pre-smolt Juvenile Salmonids

As noted above, the information available indicates breaching actions as proposed by SCWA would typically be conducted mostly in the spring and fall (25). Steelhead juveniles are most likely to be rearing in the estuary for extended periods during this time, and are the main focus below. Some coho salmon juveniles may also attempt to rear in the estuary for long time periods as described above in the *Status of the Species* section, and impacts on these coho salmon are also described below, along with potential impacts to Chinook salmon juveniles. There may be some increased predation on juvenile salmonids by harbor seals; this information is discussed above in *d. Smolts*

Steelhead. SCWA's proposed systematic breaching of the estuarine bar reduces the estuary's carrying capacity for juvenile steelhead. Large numbers of steelhead juveniles (YOY and parr) have been documented moving downstream toward the estuary. However, few juveniles have been found in the lagoon, and those that are found are either large juveniles (half-pounders) that

[65] A sudden breach which caused the surface water layer to quickly leave the estuary is likely similar to high stream flows on outgoing tides. NMFS expects downstream migrants, regardless of size, to be adapted to these conditions which would be similar to winter or spring storms breaching the bar at the mouth of the river.

are more tolerant of brackish and ocean salinities in the lower estuary, or mostly concentrated in the upstream area of the estuary, closer to Austin Creek, where the water has very little to no salt content (See description below). This suggests that few young juveniles moving downstream can survive in the estuary to become smolts or half-pounders. When the estuary is breached repeatedly to keep it open, the few juveniles in the estuary of all age classes likely experience additional degradation of water quality, a reduction in available habitat, and loss of food productivity.

Data from screw traps in the Russian River and Austin Creek show large numbers of juvenile steelhead (YOY and parr) moving downstream. In 2003 and in 2004, approximately 1,200 YOY juvenile steelhead and a few parr were caught in SCWA screw traps in the Russian River just downstream of Mirabel Dam (SCWA 2004a, SCWA 2005b). Trap efficiency for smolts was just below 10 percent. Trap efficiency for YOY and parr was likely higher (these smaller juveniles are more easily captured). Nevertheless, these numbers indicate that thousands of juvenile steelhead move downstream towards the estuary. The screw trap used in lower Austin Creek caught approximately 1,900 YOY or parr in 2005. In 2006, the same trap caught 881 YOY and 386 parr (Katz *et al.* 2006).

Several years of estuarine sampling have failed to document large numbers of YOY or parr rearing in the estuary. MSC studies in 1996, 1997, 1998, 1999, and 2000 captured fewer than 80 juvenile steelhead each year (MSC 1997, 1998, 2000, SCWA 2001a). Most of the juveniles captured were smolts. Recent SCWA studies documented somewhat higher numbers of juveniles in the estuary. In 2005, SCWA captured 438 steelhead (SCWA 2006b). In 2004, the number of steelhead captured was similar, 462 (SCWA 2005*a*). SCWA's sampling effort was greater than MSC's, which likely accounts for the larger number of steelhead captured by SCWA. In both years, the number of steelhead caught dwindled by the end of the summer (SCWA 2006*b*).

Many of the steelhead juveniles found in the estuary are found near tributary mouths, where salinities are low. Seventy six of the 103 steelhead captured in beach seines by MSC were captured near the mouth of Sheephouse or Willow Creek. More recently, in 2004 and 2005, SCWA made approximately 90 percent of their juvenile steelhead captures near the mouths of creeks (SCWA 2005a, 2006b). Most, approximately 400,were captured at the most upstream area of the estuary, near the mouth of Austin Creek where average salinity is zero (SCWA 2005*a*, 2006*b*).

Examination of other estuaries on the California Coast indicated much larger numbers of steelhead in estuaries that close during the summer. The Mattole and Navarro River lagoons, and Pescadero, San Gregorio, and Waddell Creek lagoons all had summer estimates of several thousand or over ten thousand juvenile steelhead[66]. The number of steelhead caught in these

[66] Regardless of the number of seine hauls in each estuary, catch per unit of effort (CPE - a seine pull in this case) was higher in these estuaries. For example, CPE for steelhead in the Russian River estuary was less than 2 in 2005 for all sites except the mouth of Austin Creek, where CPE was about 12 during the late spring and early summer (SCWA 2006*a*, 2006b). In the Navarro River estuary, CPE ranged from about 3.44 to 10.23, with CPE at most sites about 7 (Cannata 1998). Seine mesh sizes in other estuaries were equal or larger than mesh sizes used in the Russian River.

lagoons remained high throughout the summer and fall (Cannata 1998, Zedonis 1992, Smith 1990). Conversely, the Big River and Albion River estuaries do not close during the summer. These estuaries have very limited freshwater juvenile steelhead habitat. NMFS could find no recent juvenile steelhead population estimates for the Albion, Big River, or the Russian River estuaries. This may be because steelhead densities are too low in these estuaries to conduct population estimates via marking and recapture.

There is uncertainty regarding the capture efficiency of seining efforts in the Russian River estuary. SCWA has indicated that seine efficiency in the Russian River estuary is limited due to submerged structures and frequent depths over 3 m (SCWA 2008a). However, the Navarro River estuary is fairly large, has depths over 3 meters, and likely has submerged structures. Seining in the latter estuary captured far more steelhead, and because methods were similar, comparison of capture data from these two estuaries suggests that steelhead numbers in the Russian River estuary are low compared to estuaries that close to tidal influence during the summer or fall. If the Russian River estuary was as productive as closed estuaries on the coast, in NMFS's judgment the catch of steelhead would be much larger than current numbers reported, even in consideration of the potential for improvements to seining methodology.

Moreover, in the Russian River, Big River, and the Albion River estuaries, marine fish species such as surf perch are numerically dominant, reflecting the marine salt water environments of these estuaries during the summers (Maahs and Cannata 1998, SCWA 2006*a*, SONAR 2001). In the Navarro, and other estuaries that close and become lagoons, juvenile steelhead are the most numerous species, or one of the most numerous (Zedonis 1992, Cannata 1998, Smith 1990).

Salinity plays an important role in the distribution or number of juvenile steelhead even when open estuaries support thousands of these fish. Prior to closure of its bar in 1996 and 1997, juvenile steelhead in the Navarro River estuary were distributed by size, with the smallest juveniles (YOY) residing in the most upstream areas of the estuary that are mostly freshwater (Cannata 1998). The Garcia River, which also remains open to the ocean, contains numerous steelhead juveniles in the late spring and early summer. However, as river flows decline and salinity levels in the estuary increase throughout the summer, steelhead numbers in the estuary were observed to plummet while the numbers of some salt water fish species increased (Higgins 1995).

Recent unpublished data (Fuller, 2008b) show small numbers of juvenile steelhead in various areas of the Russian River estuary. Most of the smaller steelhead juveniles captured in 2007 (< 90 mm in fork length) were found in Freezeout Pool, an area about 1 mile downstream of Austin Creek that is often mostly freshwater (SCWA 2004b, 2006a). Larger steelhead (> 150 mm fork length) often congregated in an area Between Patty Rock to Sheephouse Creek according to 2005 and 2006 acoustic tag data (Fuller, 2008a). Salt concentration in this area at the surface fluctuate between near freshwater conditions and ocean salinity, depending on tides and whether or not the estuary is open or closed to the ocean (SCWA 2006a). At mid depths, salinities are similar to seawater unless the estuary closes. Once closed, salinities at mid depths appear to slowly decline during periods of closure. Bottom salinities remained at or near seawater during 2005 water quality sampling, regardless of bar condition (SCWA 2006a).

Repeated late spring through early fall breaching proposed by SCWA is likely to limit rearing opportunities and habitat quality for juveniles in the estuary as described above. NMFS estimates breaching (June through October) by SCWA is likely to occur between two and seven times per year, based on the breaching frequency for the period 1996-2005. The few small juveniles that reside within the estuary downstream of Austin Creek throughout the summer and fall will likely be limited to the upper area of the estuary near Austin Creek and areas near tributary mouths, where salinities are lower.

Steelhead rearing in these areas are likely to be adversely affected by a further decrease in the availability of habitat space and food supply each time the layer of freshwater is reduced during repeated fall breaching. After breaching, salmonid food production is likely disrupted by anoxic and near anoxic conditions at depth in the estuary as described above. These impacts have been found in other estuaries/lagoons. Smith (1990) found that juvenile steelhead growth rates were very good when the Waddell Creek lagoon converts to freshwater, as opposed to greatly reduced fish size during 1986 when the lagoon was breached several times. Juvenile salmonid growth rates in estuaries are usually greater than those in tributaries (Thorpe 1994). Other estuaries on the California coast that close and are not mechanically breached appear to provide increased juvenile steelhead growth during the summer (Cannata 1998, Smith 1990, Zedonis 1992, Bond 2006).

Limited growth rate data for juvenile steelhead in the Russian River estuary suggest that this area may provide good growing conditions for larger juvenile steelhead that are able to utilize the estuary, although growth data are scant. Surveys conducted by MSC in 1998 showed that juvenile steelhead residing in the Russian River estuary had similar growth rates compared to steelhead reared in tributaries (MSC 1999), suggesting that rearing in the breached estuary provided no benefit over rearing in a tributary stream. More recent data indicates that the estuary appears to provide good growth conditions for a small number of large juveniles, age class 2+ to 3+, sometimes termed half-pounders (David Manning, SCWA, personal communication, April 19, 2007). Preliminary information from other recent work shows substantial growth of steelhead (all age classes) in the estuary during 2006 and 2007, although the sample size is relatively small (Fuller, 2008).

NMFS concludes that under the proposed breaching, most of the thousands of YOY and parr steelhead moving downstream toward the estuary will: 1) perish soon after entry into the estuary due to the lack of large areas of productive freshwater rearing habitat or 2) attempt to leave the poor habitat conditions in the estuary and migrate back upstream to reach tributary rearing habitats. However, low quality habitat predominates in much of the Russian River main stem from Cloverdale to Monte Rio during the summers due to high water temperatures as described above in Section **VI.F. *Flow Management.*** In addition, low flows in the tributaries during late spring and summer will greatly limit the availability of habitat for juvenile steelhead seeking refuge from adverse conditions in the lower mainstem and estuary. Juveniles that avoid the estuary after moving downstream will not easily find high quality rearing habitat and are likely to perish or have their survival chances reduced due to poor water quality. Juveniles that reach the estuary are likely to be subject to repeated degradation of water quality and food supply via multiple breachings in the fall and spring. However, a small number of juveniles survive in the Russian River estuary during the summer and fall, and may be growing at substantial rates.

The reduction in estuarine carrying capacity and loss of juvenile steelhead that move downstream to rear in the estuary is likely to impact a large portion of juvenile steelhead in the Russian River. Data from other rivers in California confirm that juvenile migration downstream to rear in lagoons is a normal part of the life history strategy for a substantial amount of steelhead juveniles in watersheds. For example, Shapovalov and Taft (1954) found as many as 38 percent of steelhead juveniles (YOY to 4+) moved downstream to rear in the Waddell Creek lagoon for a year prior to entering the ocean. More recently, Smith (1990) observed thousands of juvenile steelhead rearing in the summer in small freshwater lagoons south of San Francisco. As many as 17,000 juvenile steelhead were estimated to be rearing in the fall in Pescadero Lagoon, with over 2,000 estimated rearing in Waddell Creek lagoon. In the Navarro River, approximately 9,000 steelhead were estimated to be rearing in the lagoon in 1997 (Cannata 1998). In Scott Creek, Bond (2006) found as many as 48 percent of the downstream migrants reared in the estuary before going to sea.

This loss of juvenile steelhead in the Russian River watershed may be magnified due to the importance of estuarine rearing for juvenile steelhead ocean survival. Bond (2006) reports that the extra growth that juveniles obtain rearing in the estuary before heading to the sea as smolts dramatically increased their chances of return to Scott Creek as adult steelhead spawners. Bond's review of data and conclusions from other river systems on the Pacific coast indicates that the size of steelhead entering the ocean is an important factor in their ocean survival. Steelhead smolts smaller than 150 mm generally have a poor chance of ocean survival. Juveniles that reared in the Scott Creek lagoon quickly increased in size by the end of the summer, with most juveniles growing larger than 150 mm. Juvenile smolts heading downstream from Scott Creek were often smaller than 150 mm. These fish did not rear in the estuary. Juveniles that did rear in the estuary comprised between 8 and 48 percent of the juvenile population for Scott Creek. These same juveniles made up 85 percent of the returning adult population (Bond 2006).

Coho salmon. Impacts to coho salmon smolts that may rear in the estuary are likely to be far less severe than impacts to juvenile steelhead. If coho salmon smolts use the Russian River estuary for rearing, residence times are likely shorter than for juvenile steelhead, as described above in the *Status of the Species* section. Shorter residence times would expose these juveniles to the spring breaching, which is more likely to mimic natural high flow breaches from spring rains than the breaching proposed for the fall.

Coho salmon have only recently been observed in the estuary. Estuarine fish surveys done in 1992-1993, 1996-2000, and 2003-2005 failed to detect coho salmon (RREITF 1994, MSC 1996-2000, SCWA 2003, 2004, 2005). This lack of detection could be the result of the very low numbers of coho salmon in the Russian River watershed, and/or that juveniles and smolts have low residency times. The low numbers of coho salmon currently in the Russian River have prompted NMFS, CDFG, and the Corps to cooperatively manage the RRCSCBP, which we have described previously in this opinion (66 FR 23833). Recent work in 2007 detected about 16 Captive Broodstock Program coho salmon in the estuary in the spring (May 14- June 7). These fish were smolting (losing parr marks, becoming silver in color) (Josh Fuller, NMFS, personal communication, 2008).

NMFS believes it likely that very small numbers of YOY coho salmon migrate downstream to the Russian River estuary in the spring and attempt to rear through the summer in some years. As described above in the *Status of the Species* section, YOY coho salmon are known to utilize estuaries for rearing and have been found in other estuaries in California. Small numbers of YOY coho have been observed in migrant traps in the Sheephouse Creek watershed, a stream that drains directly to the Russian River estuary.

In the Russian River estuary, YOY coho salmon would need to find low salinity and low temperature areas to survive. Under current management, when the bar is open, temperatures, salinities, or both, are usually too high for coho salmon to successfully rear. For example, temperatures in the upper estuary can exceed 20 ^{o}C due to the high temperatures of river inflows, and salinities in the lower estuary are nearly equivalent to seawater. When the estuary becomes closed during periods of high river temperatures, estuary temperatures can increase from those seen when the bar is open. If the bar closed in the spring, temperatures in the upper estuary would be significantly cooler and salinity in the lower estuary considerably lower, with both being within the suitable range for coho rearing. How long into the summer rearing period, and to what areal extent a suitable colder temperature regime would remain in the estuary would depend on the strength of temperature stratification of flows (lower flows=stronger stratification), and on the extent of cold tributary and groundwater inflows.

Repeated breaching to keep the estuary open to ocean tides potentially diminishes or perhaps, in some years, eliminates any areas where coho salmon can rear in the estuary. NMFS expects that breaching likely results in the loss of any YOY coho salmon in the estuary due to habitat reduction or elimination. NMFS cannot precisely determine the number of coho salmon that may be lost, but expects it is dependent on brood year success and any particular year's hydrology and summer stream conditions, which could cause any number of coho YOY to either be flushed down to, or migrate to the estuary and attempt to rear. However, we expect the number will be relatively few based on the relatively small number of coho salmon spawning in the watershed.

Chinook salmon. Breaching is unlikely to have much impact on juvenile Chinook salmon when they pass through the estuary during the spring and early summer months, as described above. Based on past breaching history, multiple breachings may occur during the spring (Table 26) but only one or two breaches are likely to occur during the summer months. Monitoring data suggests that few Chinook juveniles reside in the estuary beyond July, and those in the estuary in spring and early summer are likely large enough to survive in the marine environment, which suggests they may be more resilient to the adverse changes in water quality that occur when the estuary is breached and then closes again.

H. Channel Maintenance - Main Stem and Dry Creek

1. Effects on Habitat, Including Critical Habitat, in the Main Stem Russian River

SCWA and the MCRRFCD propose to continue bank protection, including repair or replacement of riprap, gravel bar grading, and vegetation maintenance on the main stem

Russian River. As described in the *Description of the Proposed Action*, SCWA will maintain a 22-mile reach from river mile 41 near the confluence of Maacama Creek upstream along the Russian River to river mile 63 just north of Cloverdale. In addition, SCWA will, if necessary, repair failing banks at Mirabel and Riverfront Park. MCRRFCD will conduct channel maintenance actions in Mendocino County, a 36-mile reach of the main stem Russian River from the county line north of Cloverdale upstream along the river north to the town of Calpella. The MCRRFCD also is responsible for any channel maintenance actions in the East Branch Russian below CVD downstream to the confluence with the Russian River, a one mile reach (B.Spazek, MCRRFCD, personal communication 2007). No more than four maintenance sites are proposed for work in each county during the summer months. A year's work will be limited to no more than 2,000 feet in each county, and total work for the next fifteen years will be limited to 15,000 feet in each county.

Migration habitat in the mainstem appears to be in moderate condition for all three salmonid species, as described above in the *Environmental Baseline* section. Winter flows are usually adequate for passage, and enough pools and other cover exist to allow migrants to rest and hide from predators. Spawning habitat is in generally good or moderate condition for Chinook salmon, while most steelhead spawning habitat is in moderate or poor condition. Coho salmon are not expected to spawn in the mainstem due to their life history preference for spawning in smaller streams. Rearing habitat for all three species varies depending upon location, but is in generally poor condition downstream of Cloverdale due to high water temperatures. In addition, high water levels negatively impact rearing habitat in much of the mainstem.

The SCWA and MCRRFCD have proposed minimization measures as described in the *Project Description*. These minimization measures are likely to lessen the impact of channel maintenance on salmonid habitat. For example, a 25 foot vegetative buffer strip will be left on graded gravel bars to filter sediment and help maintain habitat complexity. However, in some cases, this vegetative strip may be mowed.

Gravel bar grading is expected to reduce channel sinuosity and development of pools at the affected stream sites. Loss of pools and habitat complexity is likely to reduce suitability for migration of salmonid adults and smolts, and habitat availability for juvenile salmonids throughout the year. Juvenile rearing habitat suitability during the summer and winter may be affected through the loss of hydraulic diversity at the various channel maintenance sites (Corps and SCWA 2004). Bar grading at these sites will not be conducted in the wetted channel. However, spawning habitat may be adversely affected when rains and elevated river flows transport fine sediment from disturbed gravel bars (Corps and SCWA 2004). Delivery of fine grained sands is known to decrease spawning habitat quality and have the potential to reduce survival of incubating salmonid eggs.

Vegetation maintenance is proposed to occur at many of the gravel bar grading locations. In addition, vegetation removal is proposed at some sites for bank erosion control along the main stem channel. Corps and SCWA (2004) state that this removal of vegetation in large swaths (250-400 feet wide) along the main stem is likely to have adverse affects to salmonid habitat in the main stem Russian River. As noted in the ***Description of the Proposed Action,*** MCRRFCD will also remove obstacles including LWD that spans the channel. The

combination of gravel bar grading and vegetation maintenance is likely to further reduce the habitat complexity at the channel maintenance sites. The loss of complexity at these sites will make them less suitable for juvenile salmonids during the winter as refuge areas. Changes in the wetted portion of the channel as a response to vegetation and gravel bar grading may reduce the potential for summer rearing by juvenile steelhead, and reduce habitat for Chinook salmon and steelhead as they migrate to and from the ocean.

During any given year, the extent of impacts from channel maintenance will be limited. Corps and SCWA (2004) reports that channel maintenance actions conducted in the past generally occur at sites 10 to 300 feet in length. Given the length of channel maintenance sites in the past and the maximum length that such activities may occur (2,000 ft in each county), the length of river affected by these actions is expected to range between 600 and 4,000 ft each year. Sites that are affected by channel maintenance activities will likely have impairment of habitat conditions for one or more years until stream dynamics restore natural habitat functions to baseline conditions.

Work done by property owners on channel improvement sites covered under Public Law (PL) 84-99 will be included in the total length limits described above by SCWA if SCWA is able to ensure that property owners follow the BMPs described in the BA for this project. As described in the *Project Description* twenty one channel improvement sites associated with the CVD Project exist on the main stem Russian River from river mile 42.2 upstream to RM 61.3. USACE inspections conducted in 2000 report that most of the sites are currently stable and are unlikely to require work in the next fifteen years (Corps and SCWA 2004). Work at PL 84-99 sites may include vegetation removal and installation or repair of riprap. In some cases, a portion of the channel may need to be dewatered to effect the repair. Based on the type of bank protection repairs likely, NMFS anticipates no more than 750 lineal feet of the Russian River will need temporary diversion or dewatering during the next fifteen years to facilitate repairs.

2. Effects to Species in the Main Stem

Information is not available to allow NMFS to precisely determine the numbers of each species that will be adversely affected by channel maintenance activities in the main stem Russian River. However, NMFS has used the lineal extent of habitat affected, the likely habitat changes, the overall quality of habitat in the main stem, and available fish survey data in the Russian River to determine that small numbers of juvenile steelhead will be injured or killed, as described below.

No more than 30,000 lineal feet of the main stem Russian River will be affected by channel maintenance activities in the next fifteen years. No more than 1,000 to 2,000 feet (1-2 bars) will be graded each year in each county[67]. The loss of habitat complexity at the maintenance sites will make the habitat less suitable for adult, smolt, and juvenile Chinook salmon during the winter and spring months, but the extent of the affected sites is limited and is not expected to affect the survival of individual fish as they migrate up or downstream. Enough suitable habitat is expected to be available upstream and downstream of the channel maintenance sites

[67] As described above, each county may work as much as 2,000 feet of mainstem channel per year, but may not exceed 15,000 feet in ten years.

to allow Chinook salmon adults, smolts and juveniles to rest, feed, or find cover as they migrate.

Although there may be an increase in the amount of fine sediments in the channel resulting from transport of fine sediment from disturbed gravel bars during winter storms, this increase is unlikely to affect migrating salmonids or eggs and alevins in the gravel. Analysis done in the Alexander Valley reach of the Russian River indicated fine sediments from gravel mining are limited and minor, with small impacts to eggs or alevins (NMFS 2003b). Because the amount of gravel skimming proposed is smaller than the amount occurring in the Alexander Valley, NMFS expects the impacts to survival chances of eggs or alevins will be minimal.

Loss of habitat complexity at channel maintenance sites has the potential to affect juvenile steelhead rearing during the summer and winter. The limited number of sites affected by maintenance actions is not expected to reach a level that would adversely affect juvenile steelhead rearing during the winter, nor would it likely affect adult and smolt migrations. As above, enough suitable habitat will remain to provide adequate food, rest, and cover in the winter and spring. Reduction in summer habitat suitability in up to 2,000 (and in some years 4,000) feet of stream each year is unlikely to impact large numbers of juvenile steelhead because few juvenile steelhead inhabit the mainstem of the Russian River during the summers, due mainly to high flow releases and high water temperatures, as described above in the *Environmental Baseline and Effects of the Action* sections. Some juvenile steelhead that cannot find suitable habitat in channel maintenance areas due to lack of complexity may find other suitable habitats nearby. Others may be lost to predation as they seek better areas of cover.

NMFS used the steelhead density information in SCWA's Upper Russian River Steelhead Distribution Study (2003) to calculate an average density of juvenile steelhead in the Russian River mainstem from Healdsburg to just upstream of Ukiah (approximately 66 miles). This area matches nearly all of the mainstem affected by channel maintenance activities, and NMFS assumes that steelhead densities from this study provide a rough approximation of the number of steelhead that would be present in any given summer during the next fifteen years under the proposed project[68].

SCWA observed a total of 1,436 steelhead in 11.5 miles of surveyed channel, or 0.07 steelhead per yard. Densities ranged from a high of 0.2 steelhead per yard to as low as 0.03 steelhead per yard. Using 0.07 steelhead per yard, NMFS expects that as many as 50 to 100 juvenile steelhead in the mainstem of the Russian River could perish each year due to the loss of suitable habitats in as much as 2,000 to 4,000 feet of channel (roughly 670 to 1,300 yards) each year from channel maintenance activities. The number of juvenile steelhead lost is likely to be far lower because: 1) some steelhead will be able to find suitable rearing habitats adjacent to those lost to channel maintenance activities, and 2) NMFS does not anticipate that

[68] Steelhead densities at Mirabel and Riverfront Park are anticipated to be similar or lower. For example, 1 juvenile steelhead was captured and relocated when the Healdsburg Dam fish ladder was constructed at Riverfront Park (SCWA 2001b). In the winter, juvenile (non-smolting) steelhead densities are likely to be lower as steelhead head upstream in the fall to find cover from high winter flows.

4,000 feet, or even 2,000 feet of channel maintenance will occur in all project years, based on previous sizes of projects reported.

At PL-84-99 sites, dewatering of worksites may need to occur. NMFS assumes that no more than 750 feet of mainstem channel will need to be dewatered in the next fifteen years as described above. NMFS has used the highest steelhead densities described above to estimate that as many as 50 juvenile steelhead may need to be relocated from this area. As many as 3% of these relocated fish may be injured or killed during relocation efforts, based on the results of similar past projects. Use of the highest densities reported likely over-estimates the number of steelhead that will need to be relocated.

3. Effects to Habitat, Including Critical Habitat, in Dry Creek

As described in the *Project Description*, SCWA, via Corps authorization, maintains 15 federal bank stabilization sites in Dry Creek which have a total lineal extent of approximately one mile. These include: anchored steel jacks, 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.

Repair of these 15 bank stabilization sites can involve heavy equipment working along the banks of Dry Creek. As described in the *Project Description*, excavators or dump trucks may be used to place earth or rock. Bulldozers may be used to change the shape of channel banks. Dewatering of adjacent stream reaches will not occur, and equipment operating from stream banks may conduct activities in flowing water, such as digging toe trenches and placing riprap. Bank stabilization repair activities will occur from June 15 to October 31.

Salmonid habitat, including critical habitat, may be adversely affected due to bank stabilization work in these areas. Vegetative cover over and in the stream is likely to be reduced or eliminated, undercut banks are likely to be eliminated, and parts of mechanical equipment (excavator buckets) will temporarily enter aquatic habitat. These areas, and areas directly downstream, will experience temporary increases in turbidity levels and increases in sedimentation during and after bank stabilization work. Localized changes in channel hydraulics are also likely.

The main effects to migration habitat are limited vegetation removal and maintenance of riprap at some of the bank stabilization sites. Vegetation removal and riprap reduce the amount of vegetative cover available for adult salmonids to use as velocity refuges and to hide from predators during spawning migrations. Removal of undercut banks also reduces the amount of cover and velocity refuge available for migrating adults.

Spawning habitat will experience similar cover loss. 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.

Channel maintenance is likely to adversely affect rearing habitat in several ways. Vegetation removal and bank hardening is likely to reduce or eliminate the recruitment of large woody debris (LWD) to Dry Creek. The loss of complexity at these sites is likely to reduce cover from predators and velocity refuges from winter flows, and, over time, is expected to adversely affect winter and summer rearing habitat as bank protection work continues during the next fifteen years. The removal of undercut banks will also eliminate habitat that provides hiding cover and velocity refuges. Instream cover needed by steelhead for velocity refuge and concealment from predators is already limited in the mainstem of Dry creek. Implementation of the proposed project will help to maintain these conditions, and may exacerbate them if cover is removed during maintenance activities. NMFS notes, however, that some of the bank protection methods themselves (jacks, for example) can provide cover and velocity refuge, and may ameliorate the loss of vegetation and undercut banks to some extent at some of the bank protection sites.

Additional sediment entry to Dry Creek is likely to settle in pools, making them shallower, and eliminating aquatic insects that juvenile salmonids feed upon. Additionally, the use of hard-armoring techniques such as riprap can prevent the establishment of a native riparian corridor over the long term. This in turn affects rearing habitat by reducing canopy cover and increasing water temperatures for summer rearing. A reduction in canopy cover is likely to have the largest habitat impact in the lower section of Dry Creek where canopy cover is currently sparse.

Overall, managing the system of bank stabilization sites on Dry Creek is likely to continue to maintain reduced habitat suitability conditions for juvenile salmon and steelhead in portions of Dry Creek. The upper three miles of Dry Creek have a high number of stabilization sites that inhibit the function and development of optimal habitat. The middle and lower reaches of Dry Creek have a lower density of stabilization sites, and therefore, maintenance of these sites is less likely to affect the overall condition of habitat for juvenile salmonids in those stream segments.

4. Effects to Species in Dry Creek

Information is not available to allow NMFS to precisely determine the numbers of each species that will be adversely affected by channel maintenance activities in Dry Creek[69]. NMFS has used the lineal extent of habitat affected (5,800 ft), the likely habitat changes and direct effects, and overall quality of habitat in Dry Creek to determine that small numbers of each species at specific life history stages will be injured or killed, as described below. The actual extent of effects is likely to be smaller, as many sites do not need maintenance on a yearly basis.

Adult Chinook salmon and steelhead will likely be adversely affected if they encounter spawning habitat that has been degraded as described above. For example, they may be lost to predators if pools or cover are degraded. NMFS believes the number of adults adversely affected will be low because: 1) the number and size of bank protection sites in Dry Creek (approximately 1 mile total, 600 feet per year) is limited compared to the 12 miles of known spawning habitat in Dry Creek (SCWA 2004c, SCWA 2007a), and 2) although some aspects of spawning habitats are

[69] For example, there are no recent juvenile density estimates for the mainstem of Dry Creek.

already limited in Dry Creek, the relatively large numbers of Chinook salmon and steelhead that have been observed spawning this stream indicate that much of the mainstem of Dry Creek is suitable for spawning, regardless of the limited amount of instream cover for spawners.

Due to the abundance of Chinook and steelhead spawners in Dry Creek (as noted in the *Environmental Baseline* section), the limited extent of channel maintenance work during the next fifteen years, and the apparent availability of suitable spawning sites throughout Dry Creek, NMFS anticipates roughly no more than 2 Chinook salmon and steelhead adult spawners are likely to be unable to find appropriate cover in Dry Creek for spawning per year due to channel maintenance activities. These fish are likely to be lost to predators before they are able to spawn.

NMFS does not expect that many eggs and alevins of Chinook salmon or steelhead will be adversely affected by work at bank stabilization sites in Dry Creek. The size of bank stabilization sites is limited and females of both species clean gravels prior to spawning. Impacts to steelhead eggs and alevins are not likely because this species spawns in late winter and spring, when high seasonal flows in Dry Creek will help clean fine sediments from spawning gravels. A few Chinook redds may be adversely affected. NMFS expects no more than 2 Chinook redds per year could have the survival of their eggs and alevins reduced. This estimate is probably high because work in any given year may or may not contribute sediment to Dry Creek.

Direct disturbance of flowing water by construction equipment may injure or kill juvenile steelhead at the bank protection sites. Some juveniles at the sites are likely to seek refuge in undercut banks or near other areas that will be disturbed or eliminated by heavy equipment. These fish may be injured or killed during bank protection repair operations. SCWA's placement of barriers to prevent sediment and turbidity downstream of the repair sites may exacerbate injury to juvenile steelhead that remain at the sites by concentrating turbidity in the construction areas.

Juvenile steelhead are likely to be adversely affected by the loss of channel complexity at these sites once construction activities are completed. Juvenile steelhead in the lower section of Dry Creek are more likely to be adversely affected because habitat conditions in this area are less suitable due to more limited sheltering cover and shade. Steelhead attempting to rear in some of these sites are likely to be exposed to higher rates of predation and higher water temperatures that may be injurious.

NMFS believes that the number of juvenile steelhead adversely affected by these activities will be limited, because 1) the sites comprise only a relatively small portion of rearing habitat in Dry Creek, and SCWA will only operate yearly on 10% of the total lineal extent of the sites (roughly 600 feet per year), 2) not all sites or work at sites eliminate rearing habitat, 3) not all juvenile steelhead will remain at sites where work is conducted in flowing water, and 4) few juvenile steelhead are likely to be present in Dry Creek due to the high summer water velocities, as described above. Steelhead juveniles forced to move because of habitat loss from bank stabilization may not be able to find cover from high flows and other resources they need to survive in Dry Creek.

As previously described, juvenile Chinook salmon rear in fresh water for a very brief period, usually two to four months (February through May) before emigrating to the ocean (Corps and SCWA 2004). Some Chinook salmon smolts may still be emigrating from the system in June; however, most of these fish will already have passed downstream into the ocean by the time channel maintenance takes place (Corps and SCWA 2004). Therefore, effects to juvenile Chinook salmon from channel maintenance activities are not likely.

Coho salmon have not been observed in the mainstem of Dry Creek since the 1990s; however, there is little current information on the distribution of salmonids, especially juvenile stages, in Dry Creek. As described above, NMFS expects few coho salmon are present in Dry Creek during the summer due to high stream flows and lack of velocity cover. Impacts to coho salmon due to channel maintenance in Dry Creek would likely be similar to those described for steelhead.

I. Channel Maintenance - Zone 1A Constructed and Natural Waterways

The following section describes the effects of SCWAs channel maintenance activities to the PCE's of habitat, including critical habitat, and salmonids in the Zone 1A tributary area. Similar to the *Environmental Baseline* section on this area, this section is divided into two parts: constructed flood control channels and natural waterways. The first part of this section covers constructed flood control channels found in Santa Rosa Creek and the Rohnert Park-Cotati area. The second part of the section covers natural waterways which include the upper portions of the Santa Rosa Creek and Rohnert Park-Cotati area.

1. Effects to Habitat, including Critical Habitat in Constructed Flood Control Channels

SCWA conducts sediment removal, LWD removal, vegetation maintenance/removal, and bank stabilization activities in Zone 1A constructed flood control channels (Figure 3, Tables 28 and 29). These activities are conducted between June 15 and October 31, when most flood control channels are dry. The frequencies, locations, and magnitudes of these activities vary, as described briefly below.

Sediment removal activities can occur throughout constructed flood control channels in the Zone 1A tributaries, however, sediment removal is conducted primarily in the Rohnert Park-Cotati area. Sediment removal is conducted on an as-needed basis. Some of the constructed flood control channels require annual sediment removal, some require sediment removal approximately every 5 to 10 years, and some have never required sediment removal.

Some creeks may not experience sediment removal during the next fifteen years. One exception to this is Copeland Creek (Rohnert Park-Cotati), where sediment removal occurs fairly frequently, about every one to three years (Table 28). In 1997, 100 percent of this constructed flood control channel was cleaned; however, in 2000, only 17 percent (2000 feet) was cleaned. Santa Rosa Creek, the Laguna de Santa Rosa, and Windsor Creek are also likely to experience sediment removal during the next fifteen years. The frequency of work needed in these channels can change from year to year depending on land-use practices that potentially alter sediment

supply conditions. The other channels in Tables 28 and 29 are unlikely to experience sediment removal during the project time period.

In addition, SCWA will also remove sediment at road crossings (in and adjacent to culverts, for example) and at culvert outfalls. SCWA anticipates no more than three sediment removal actions at road crossings and outfalls annually in constructed flood control channels in the following areas or watersheds: Laguna de Santa Rosa, Santa Rosa Creek, Copeland Creek, and Windsor Creek. As noted in the project description, work will occur in the summers when these channels are dry.

Woody debris removal in flood control channels is very limited due to the flashy nature of these channels; they are able to pass even large trees fairly efficiently. SCWA estimates an average of half a dozen pieces of LWD are removed annually from flood control channels. They are removed from the top of the bank with a winch, cut up and transported away.

The lineal extent of vegetation removal will occur as described in Table 28 and Table 29. There are three different levels of vegetation maintenance/removal in the constructed flood control channels: original design, intermediate and mature. Approximately 75 percent of the vegetation is removed with the original design method, leaving only vegetation near the top of the bankfull channel and vegetation set back from the top of the bank. This type of vegetation maintenance occurs in Paulin, Piner, Santa Rosa, Brush, Crane, Laguna de Santa Rosa Creek, Rinconada, Copeland and Todd Creek. The intermediate and mature methods occur on other channels and do not have much affect on habitat or species because very little vegetation is removed with these methods.

Bank stabilization projects have been infrequent and will likely continue to be infrequent during the next fifteen years. These projects may occur in any constructed flood control channel in the Zone 1A area.

Overall, SCWA's channel maintenance actions, when added to the poor baseline conditions found in the creek reaches classified as "Constructed Flood Control Channels", prevent habitat conditions in these channels from improving. In the portions of these creeks characterized as "Constructed Flood Control Channels" flows have been channelized and much of the banks have been hardened with rock and concrete. Sediment and vegetation would build up in these areas during the next fifteen years without SCWA's proposed maintenance activities, and would provide some improvement to salmonid habitat. However, because channelization and bank hardening has disrupted salmonid habitat forming processes in these areas, habitat conditions would not improve dramatically if SCWA's maintenance activities did not occur.

Table 28. Frequency and extent of sediment and vegetation removal in Zone 1A constructed flood control channels in the Rohnert

Constructed flood control channel name	Total constructed channel length (ft)	% channel worked for sediment	Frequency of Work Sediment	Comments	% stream worked for vegetation	Frequency of work vegetation	Recent steelhead Presence (2006)
Laguna de Santa Rosa	24,200	10%	5-10yrs	Last cleaned in 1992/93	25-50%	annually	X
Coleman	3,300		1-5yrs	Last cleaned in 1997			
Copeland	19,250	17%	1-3yrs	Last cleaned in 2000	25-50%	annually	X
Copeland South Fork	4,000	100%	10-20yrs	Last cleaned 1986/87			
Cotati	1,000	100%	5-10yrs	Not cleaned in last 5yrs			
Crane	800	100%	5-10yrs	Last cleaned in 1991/92			
Five	6,600	100%	5-10yrs	Last cleaned in 2000	25-50%	1-5yrs	
Gossage	7,700	90%	5-10yrs	Last cleaned 1989/98			
Hinebaugh	13,200	25%	1-5yrs	1989/95/99 3 separate reaches of approx. 1,000 feet			
Hunter Lane	6,600	100%	5-10yrs	Last cleaned 2000	<25%	annually	
Spivok	1,600		5-10yrs	Not cleaned in last 5 yrs	<25%	annually	
Washoe	1,600	100%	5-10yrs	Not cleaned in last 5 yrs	<25%	annually	
Wilfred	22,000	100%	5-10yrs	Last cleaned 1989/95			
Starr	2,500	100%	10-20yrs	Last cleaned 1985/86	25-50%	annually	

Park/Cotati area.

a. Migration Habitat

Sediment removal activities may limit migration opportunities for salmonids, especially during low flow winter conditions. Sediment removal eliminates small lateral bars, which in turn, reduces the sinuosity of the channel. This loss of sinuosity creates a laminar flow and reduces the depth of the channel, resulting in fish passage barriers for adult upstream migration in these tributaries during low flow winter conditions. Most steelhead migrate as flows recede after winter storms; however, due to the degraded habitat described above, their migration opportunities during these times will be more limited. Steelhead generally require a minimum depth of about seven inches for upstream migration (Thompson 1972) and many of these streams have less than ½ foot of depth when extended periods of low rainfall occur during the fall and winter (Corps and SCWA 2004). Therefore, sediment removal may exacerbate this problem, limiting migration to periods when flows are higher and depth is adequate for passage. In stream segments where a thalweg is not re-established over the winter, smolt outmigration may be affected in the spring as well. Sediment removal at road crossings may improve migration conditions, depending upon the amount of sediment in the crossing and the impact of the crossing on migration habitat regardless of sediment build-up.

The loss of vegetation along channel banks and in stream channels due to vegetation maintenance, sediment removal, bank stabilization, and LWD removal affects migration habitat by decreasing hiding cover for both adults and juveniles during migration. LWD and vegetation removal also reduces the amount of velocity refuges available for adults during their migration.

b. Spawning Habitat

Sediment removal reduces the potential for spawning areas to develop by simplifying the channel. As above, NMFS notes that 20th Century channelization practices have straightened constructed flood control channels and dramatically reduced the ability of these channels to form spawning habitat. Sediment removal reduces channel complexity and sinuosity, thereby preventing the natural formation of pool/riffle habitat. The downstream end of pools or the head of riffles is the location of most spawning habitat. Without these features, the formation and extent of spawning habitat is compromised. Spawning salmonids also need pools for velocity refuges during high flows.

Vegetation removal, including removal from bank stabilization, will likely result in increased sedimentation in these channels. Vegetation along stream banks traps fine sediments as they are washed toward streams during rainstorms. Removing vegetation along channel banks increases the amount of fine sediments entering stream channels. Increased sedimentation reduces the quality of spawning gravels for incubating eggs by decreasing the amount of dissolved oxygen available to them.

Vegetation and LWD removal affects spawning salmonids by exposing them to predation and disturbance. Overhanging and submerged vegetation provides hiding cover (protection from predators) and disturbance for adult salmonids during the spawning season (Bisson *et al*. 1987 and Bjornn and Reiser 1991). LWD provides velocity refuges needed by adult spawners during

high flows. As described in the baseline, there is already a limited amount of cover such as instream vegetation and LWD in all the flood control channels. In some locations rip-rap is needed to help stabilize the banks. When this occurs vegetation is obstructed from growing in these locations. The use of rip-rap also reduces recruitment of spawning gravel for salmonids (USFWS 2004).

c. Rearing habitat

Sediment removal activities also have the potential to adversely affect rearing habitat for salmonids. Similar to migration and spawning habitat, sediment removal activities can affect rearing habitat by eliminating small lateral bars, and associated in-channel vegetation needed to create the small amounts of sinuosity possible in these channels. This loss of a sinuous, narrow channel and of lateral bars also reduces the formation of pool/riffle habitat. Loss of pool habitat and cover from sediment removal (and LWD removal and vegetation management - see below) is a particular concern for coho salmon critical habitat, because coho salmon juveniles prefer deep, dark pools for rearing.

SCWA intends to reestablish sinuosity in some of the low-flow channels following sediment removal activities. This activity occurred in one section of Copeland Creek. However, unless this is done every time sediment is removed, the effects described above will likely continue at each sediment removal site. In some areas, reestablishing sinuosity will not be possible due to channel constraints from hardened banks and nearby public or private buildings.

The removal of living vegetation and LWD results in a reduction in cover needed by juvenile salmonids for protection from predators as well as a reduction in foraging sites.
Living vegetation and LWD create complex lateral habitats such as backwaters, eddies, and side channels. These areas serve as rearing areas for juvenile fish and provide critical refuge during floods (Gregory *et al.* 1991). LWD also adds to habitat complexity by scouring pools with woody debris for cover. Habitat complexity and cover are already severely lacking in these flood control channels and the removal of living vegetation and LWD only exacerbates this problem. Vegetation removal results in reduced shade, which can increase water temperatures beyond juvenile tolerances. High water temperatures are a particular concern for coho salmon, which have a lower tolerance for high temperatures compared to steelhead. Reduced riparian vegetation has also resulted in numerous sites with decreasing bank stability, which increases the potential for erosion and sedimentation. These sites then contribute fine sediments to the channels which fill in rearing pools, making them shallower.

The reduction of LWD and living vegetation also reduces invertebrates in the channel by limiting their food source or substrate in which they live. Similarly, by disturbing the bed and banks of streams, sediment removal may bury aquatic insects that juvenile salmonids feed on. These aquatic insects are an important component of the diet of juvenile salmonids.

Most of the impacts described above for rearing habitat are most likely to occur in channels where the “original design” method for vegetation maintenance is used, and in those creeks where most sediment removal is likely to occur. SCWA does intend to use bioengineering

techniques whenever feasible, which will reduce the impacts of LWD, sediment and vegetation removal on salmonid habitat.

Herbicide applications on service roads and in channels are unlikely to have adverse effects on salmonid habitat. SCWA will use Aquamaster®, a glyphosate herbicide approved by EPA for aquatic use in channels and on service roads. Agri-Dex®, a surfactant, will be added to the herbicide when road application occurs. NMFS has approved both in the past for channel maintenance and weed control due to their limited impacts on primary constituent elements of listed salmonid critical habitat (NMFS 2003a).

2. Effects on Species From Activities in Constructed Flood Control Channels

Steelhead are likely to be present in the constructed flood control reaches of Laguna de Santa Rosa, Copeland Creek, Brush Creek, Paulin Creek, and Santa Rosa Creek, where they have been observed as recently as 2006 (Chase 2008). Steelhead may also be present in the other channels indicated in Table 2 in the *Description of the Proposed Action*. Chinook adults and smolts have been documented migrating in a portion of Santa Rosa Creek (David Manning, SCWA, personal communication, March 25, 2008). Based on their life history, CC Chinook salmon are not likely to be present in the summer months; they migrate to the ocean by May or June. Therefore, direct impacts on rearing Chinook salmon from the implementation of maintenance activities are of limited concern. The best available information on the distribution and abundance of CCC coho salmon indicate that they are not likely to rear or migrate through the constructed flood control channels of the Zone 1A tributary area, and thus are not likely to be present. Coho salmon have not been observed in the flood control channels since 1994 (when they were observed in Santa Rosa Creek) and then only a few were observed. Coho salmon are thus likely extirpated from these areas and are not considered further in this section.

Specific information on the numbers of Chinook salmon and steelhead present in these creeks is limited or unavailable. NMFS used the limited fish survey information available, the frequency of channel maintenance activities (Tables 28 and 29), the lineal extent of channels affected, and the types of adverse effects to habitat to determine that small numbers of listed salmonids are likely to be adversely affected, as described in the text below.

Salmonids migrating through the creeks listed above may be delayed by the channel conditions resulting from maintenance in constructed flood control channels, and they may experience additional risk of predation. Some steelhead and Chinook adults and smolts may not survive their journeys through these areas. Some adults that do survive may experience reduced spawning success due to the additional energy cost of migrating through degraded habitat. Migrating Chinook salmon may be more affected than steelhead by the impacts to migration habitat described above. Chinook salmon migrate upstream in the Russian River in the late summer and fall when flows and water depth are already low, making passage difficult and leaving Chinook salmon more exposed to predation. The additional loss of channel sinuosity and vegetative cover due to channel maintenance activities are likely to exacerbate these conditions as described above.

NMFS believes only a small portion of the salmonids migrating in these creeks will fail to survive migration through these areas because the barriers to migration created by low flows will be limited in duration based on flow and channel conditions. During other times, flows will be high enough to allow migrating salmonids access to resting and hiding cover at the edges of channel beds (trees, large woody debris, etc.) for listed salmonids to migrate[70]. When flows are low and migration is difficult or delayed, the lack of cover in these areas will expose the fish to predation. These effects are most likely to occur in Copeland Creek, the Laguna de Santa Rosa, and Santa Rosa Creek as a result of the proposed project due to the expected frequency and lineal extent of sediment removal work in these channels in the next fifteen years. Sediment removal is not anticipated to occur in most other constructed flood control channels that contain steelhead, and it will affect only a small portion of habitat one time in the next fifteen years in Windsor Creek. Sediment removal at road crossings may improve migration success through some areas of these channels.

As noted above, suitable spawning sites are likely to be limited in these creeks as the result of both 20th Century channelization and ongoing maintenance activities. Adult steelhead and Chinook salmon are likely to expend energy moving up or downstream to find better spawning habitats. Again, the limited amount of instream and overstream cover from vegetation and LWD in these streams will expose these spawners to predation. If spawning occurs, egg survival is likely to be low due to increased fine sediments in spawning gravels. While spawning sites are improbable in the constructed flood control channels, it is likely that spawners would move upstream to better spawning sites likely present in the natural waterway portions of many of these streams. This is contingent, however, on their ability to migrate successfully to these locations, which is likely to be problematic when winter flows between storms drop to low levels.

Vegetation removal activities are likely to adversely affect juvenile steelhead, particularly when the original design method of vegetation removal occurs (removal of approximately 75% vegetation or more). This type of vegetation maintenance occurs in creeks where steelhead were recently observed: Paulin, Santa Rosa, Brush, Laguna de Santa Rosa, and Copeland creeks. Vegetation removal occurs in each of these creeks annually. The portion of the stream where vegetation is removed can be up to 25 percent of the constructed waterway area, with the exception of Copeland Creek and the Laguna de Santa Rosa where 25 to 50 percent of the designated constructed waterways are subject to vegetation removal. Adverse effects to rearing steelhead juveniles are most likely to occur in these creeks due to the extensive amount of vegetation removed and the associated effects to steelhead habitat (*e.g.*, loss of shade and cover). These activities are likely to result in the injury or death of some juvenile steelhead in some years.

Herbicide application in these channels is unlikely to adversely affect salmonids because SCWA is using glyphosate herbicides and surfactants in diluted amounts. The LC50 for glyphosate is 38 parts per million (ppm) for a 96 hour exposure for rainbow trout and 930 ppm for *Daphnia magna* (water flea) (CADPR 1998), so it would take a very heavy application to cause detectable effects. Two studies of the acute lethality of the surfactant Agri-dex reveal a LC50 range from

[70] See, for example, photo documentation of channel conditions in the constructed flood control portion of Copeland Creek (Entrix 2002).

271 to >1000 ppm (SERA 1997; Smith *et al*. 2004). Even the lower end of this range is highly unlikely to be encountered in a waterbody under any conditions other than a product spill.

NMFS estimates (with concurrence from SCWA 2008f) that sediment removal is likely to occur three times in the Laguna de Santa Rosa, six times in Copeland Creek, once in Windsor Creek, and three times in Santa Rosa Creek in the next fifteen years, based on the frequencies provided in Table 28 and 29. Habitat disturbance from sediment removal will be limited to 2,400 feet in the Laguna de Santa Rosa, 3,270 feet in Copeland Creek, 500 feet in Windsor Creek each time sediment removal activities occur. In Santa Rosa Creek, a total of 4,000 feet of sediment will be removed three times during the next fifteen years. In addition, approximately 500 cubic yards of sediment will be removed annually from the diversion channel near the vortex tube and v-sill at the Spring Lake diversion structure (SCWA 2008b).

Because the constructed flood control channel portions of these creeks provide limited baseline summer rearing habitat for steelhead, few juvenile steelhead are likely to experience direct impacts. For example, in Copeland Creek, juvenile densities ranged from 0.06 steelhead per linear foot of stream to 0.01 steelhead per foot, depending on location and when steelhead were present (Entrix 2002)[71]. Juvenile steelhead will be relocated if they are occupying sediment removal sites (see below). Overall, most of these adverse effects to steelhead juveniles are most likely to occur in Copeland Creek, Santa Rosa Creek, and Laguna de Santa Rosa Creek due to the combined impacts of both sediment and vegetation removal in the constructed flood control channel portions of these creeks.

SCWA's channel maintenance program for the constructed flood control channels in the Zone 1A tributaries contributes to ensuring that degraded habitat conditions are likely to persist for the next fifteen years. However, NMFS notes that these channels run through and around housing developments, and under/along roadways. Without SCWA's channel maintenance activities, it is unlikely habitat conditions, and impacts to listed species, would dramatically improve in the next fifteen years.

While SCWA will make efforts to contain sediment, it is possible that some sediment may enter the channel during channel maintenance activities taking place along stream banks, thereby temporarily increasing the turbidity of the water. Steelhead juveniles are "sight feeders" and excessive turbidity in the water can reduce their ability to feed (Corps and SCWA 2004). Based the limited amount of sediment that may enter stream channels, and the short duration of increased turbidity associated with this action NMFS does not expect adverse effects to steelhead juveniles from activities on dry stream banks.

If channel maintenance activities occur in wetted channels and salmonids are found to be present, SCWA will relocate salmonids from the project reach and install barriers to exclude fish from the area during channel maintenance work. For example, the sediment removal at the Spring Lake Diversion Structure requires dewatering and fish relocation[72]. Nearly all salmonids

[71] NMFS notes that the density of juvenile steelhead in Copeland Creek flood control channel is generally lower that in the mainstem Russian River.

[72] Barriers and fish rescues are unlikely in most of the constructed flood control channels because steelhead have not been found at sediment removal sites (S. White, SCWA, personal communication, 2004).

present are expected to be juvenile steelhead. There is a small chance that Chinook salmon adults or juveniles would be present. It is possible that not all salmonids will be relocated; if so these fish would experience direct injury or mortality from maintenance equipment. Temporary relocation or displacement of salmonids may cause injury or death to salmonids by subjecting them to stress, increased competition, or predation. Based on information from other relocation efforts, NMFS expects injury and mortalities will be limited to 3% of those salmonids that are relocated. The low densities of steelhead in these channels indicate that few, if any, will need relocation.

Overall, direct effects to steelhead (or Chinook salmon) from relocation due to in channel work are likely to be limited to areas where vegetation removal, LWD removal, bank stabilization, and sediment removal occur and disturb aquatic habitat. Most of the in-channel work is sediment removal, and most sediment removal occurs in the Rohnert Park-Cotati area. Few, if any, rearing juvenile Chinook salmon are likely to experience adverse effects because channel maintenance activities will occur in the summer months and early fall when Chinook juveniles have already emigrated to the ocean. Few, if any, Chinook adults are likely to be present. There is a small chance early migrants will enter these creeks in the late summer; however NMFS expects this occurrence to be negligible because of low flows and elevated water temperatures in the creeks during late summer. The direct adverse effects described above are most likely to occur to juvenile steelhead in Copeland Creek, the Laguna de Santa Rosa, Santa Rosa Creek and Windsor Creek due to the higher frequency of sediment removal activities described above. These fish are unlikely to experience direct adverse effects from sediment removal at road crossings or outfalls because this work will be done when stream channels are dry.

Table 29. Frequency and extent of sediment and vegetation removal in Zone 1A constructed flood control channels in the Santa Rosa area.

Constructed flood control channel name	Total constructed channel length (ft)	% channel worked for sediment	Frequency of Work Sediment	Comments	% stream worked for vegetation	Frequency of work vegetation	Steelhead Presence
Brush	12,100		>20 yrs	Self cleaning	<25%	annually	X
Oakmont	6,600		>10 yrs	No sediment removal	<25%	1-5 yrs	X
Paulin	15,400		>20yrs	Self cleaning	<25%	annually	X
Piner	12,000	50%	>10yrs	Last cleaned in 1989			X
Santa Rosa	48,400		>20yrs	Self cleaning	25%	annually	X
Todd	15,400	40%	5-10 yrs	Not cleaned in last 5 yrs	25-50%	annually	
Austin	5000		>20 yrs	Self cleaning	<50%	annually	X
Colgan	19,250	50%	5-10yrs	Last cleaned in 2000		annually	
College	4,400		>20yrs	Self cleaning	25-50%	annually	
Forestview	3,850		>20yrs	Self cleaning	75-100%	annually	
Indian	1,650	100%	>10yrs	Last cleaned in 1999	<25%	annually	
Kawana Springs	2,200	100%	10-20yrs	1988/89	<25%	annually	
Lornadell	1,200	100%	5-10yrs	Last cleaned 1987/88	<25%	1-5 yrs	
Matanzas	2,500	100%	>10yrs	Last cleaned 1988/89			X
Peterson	8,800		>20yrs	Self cleaning	50-75%	annually	X
Roseland	23,000		5-10yrs	Not cleaned in last 5yrs	25-50%	annually	
Russell	3,800	100%	5-10yrs	Last cleaned 1989/97	50-75%	annually	
Sierra	1,600		>20yrs	Hydraulic only/ no sediment removal	<25%	annually	X
Steele	12,000	20%	10-20yrs	Last cleaned in 2003	25-50%	annually	
Wendell	6,100	50%	50-10yrs	Not cleaned in last 5yrs	50-75%	annually	
Windsor	5,000	50%	5-10yrs	Not cleaned in last 5yrs			X

3. Effects to Habitat in Natural Waterways

Migration, spawning, and rearing habitat for steelhead and Chinook salmon is likely to be minimally affected by channel maintenance activities in the natural waterway portions of streams in the Zone 1A area. As described above in ***IV. Description of the Proposed Action***, channel maintenance activities will not occur in natural waterways used by coho salmon. Maintenance does not occur in these sections of the streams as regularly as it does in the constructed flood control channels. However, where such activities are implemented to restore channel hydraulic capacity, the effects to salmonids from vegetation, LWD, and sediment removal activities, as well as from bank stabilization in natural waterways, are similar to those described above for the constructed flood control channels. There are a few minor differences and these are described below.

a. Sediment Removal and Bank Stabilization

Sediment removal and bank stabilization activities have the potential to affect rearing habitat in natural waterways. However, SCWA does not perform routine sediment removal activities in natural waterways. When sediment removal and bank stabilization does occur it is typically conducted at discrete, selected sites. Based on past activities, SCWA estimates that sediment removal activities occur about once every 10 years in natural waterways. This is about the same frequency as sediment removal activities in some of the constructed flood control channels. While the frequency is about the same, the extent or size of sediment removal is limited in natural waterways to small areas associated with downed trees, therefore, effects to steelhead rearing habitat are much more limited during the next fifteen years than in the constructed flood control channels. In addition, guidelines for incorporating bio-engineering, revegetation, and fish habitat elements into bank stabilization work should help reduce impacts from sediment removal and bank stabilization activities in these streams. Sediment removal and bank stabilization will be conducted during the summer and fall months when flow is minimal. If flow is present in the channel, it is diverted by using an earthen coffer dam, pea gravel or by using a clean bypass. If salmonids are likely present, fish relocations will be conducted. Work is performed using backhoes, excavators, and dump trucks. Unlike the flood control channels, access roads may not be available for work needed in natural waterways. NMFS assumes that in some cases access roads will be needed for equipment to enter the channel and remove sediment. The creation of such roads will likely increase the potential for sediment and turbidity to enter channels, as well as removing canopy cover. SCWA will employ upslope sediment control measures such as silt fences which will reduce sediment inputs.

b. Vegetation and Debris Removal

Current vegetation removal practices in natural waterways require retention of a shade canopy over stream channels and underbrush removal. It is estimated that no more than 25 percent of the in-channel vegetation would be removed at any given site. The length of vegetation removed is limited to small projects, usually 300 to 600 feet in length. SCWA anticipates no more than three vegetation removal actions in each natural waterway per year (SCWA 2008b). Vegetation removal in constructed flood control channels is not limited in length and some of the sites have 75 percent or more of the vegetation removed, therefore, compared to the constructed flood

control channels, affects to steelhead habitat due to vegetation removal are expected to be lower in natural waterways. Though individual projects in natural waterways may have limited impacts to habitat, the sum of several projects may have a larger net effect. This is especially true for creeks with important spawning and rearing habitat such as the natural waterway portion of Santa Rosa Creek.

Natural waterways that potentially support summer rearing within or upstream of sites where vegetation and debris removal activities are likely to occur will experience a reduction in rearing habitat quality. Vegetation and debris removal impact the habitat by reducing cover in and along the channel edge, by reducing habitat complexity, by increasing water temperatures, and by decreasing bank stability which increases the potential for erosion and sedimentation. The reduction of vegetation and debris also affects aquatic insects in the channel by limiting their food source or substrate in which they live. These aquatic insects are part of the food chain which support salmonids.

Herbicides may be used in natural waterways, although road spraying will not occur adjacent to these areas. The effects are expected to be negligible for critical habitat as described above for the constructed flood control channels.

4. Effects to Species in Natural Waterways

Information is not available to allow NMFS to precisely determine the numbers of each species that will be adversely affected by channel maintenance activities in Natural Waterways. NMFS has used the lineal extent of habitat affected, the likely frequency of projects, the habitat changes described above, likely direct effects, and overall quality of habitat in Natural Waterways to determine that small numbers of each species at specific life history stages will be injured or killed, as described below.

SCWA's sediment removal activities will only occur one to two times in each natural waterway during the next fifteen years, and that removal activities will affect 50 lineal feet or less of aquatic habitat in each waterway. Vegetation removal activities will be limited to no longer than 600 feet with no more than 25% of the vegetation removed from no more than three sites per year in each natural waterway.

In most of the natural waterways, only steelhead adults and smolts are expected to be present. Chinook adults and smolts have not been documented in any of the tributaries of the Rohnert Park-Cotati area to date, however, they have recently been found in Santa Rosa Creek. Based on their life history, there is only a small chance that Chinook salmon adults or juveniles could be present. Therefore, effects to species in the natural waterways are not as much of a concern for Chinook salmon as it is for steelhead. As noted in the project description, SCWA will not conduct channel maintenance activities in creeks inhabited by coho salmon. Similar to the constructed flood control channels, herbicides used by SCWA in natural waterways are unlikely to adversely affect listed salmonids because the concentrations used are small.

Effects to steelhead and Chinook salmon during all life stages from channel maintenance activities are similar to the effects described above for salmonids in the constructed flood control

channels. However, according to the Corps and SCWA (2004), maintenance activities generally occur in smaller areas than in constructed flood control channels. In addition, the limits to vegetation maintenance and sediment removal activities described above reduce impacts to the habitat and thus to the species. The natural waterways are characterized by fairly good habitat with adequate canopy and instream cover, cooler water temperatures, and adequate foraging sites. Assuming that the frequencies and magnitude of all maintenance activities in natural waterways are low, only low numbers of steelhead, Chinook or coho salmon are likely to be adversely affected by adverse changes to habitat in these streams.

Overall, direct effects to steelhead or Chinook salmon juveniles from in channel work in natural waterways are likely to be limited to areas with increased potential for flooding due to reduced hydraulic capacity. These maintenance activities are expected to be infrequent, as described above, but may adversely affect juvenile steelhead or Chinook salmon due to direct disturbance of aquatic habitat and fish relocation. Adverse affects to juvenile Chinook salmon are probably few since the channel maintenance activities will occur in the summer months and early fall when most Chinook juveniles have already emigrated to the ocean. Migrating salmonids are not likely to be adversely affected due to the small sizes of sediment removal sites and the relative abundance of hiding and resting cover in natural waterways.

The only coho salmon found in Zone 1A were in the Mark West Creek mainstem in 2002. They are not likely to be in other natural waterways in Zone 1A, nor are they likely to inhabit streams above constructed flood control channels in Zone 1A[73]. In Zone 1A, steelhead are known to inhabit many tributaries in the Mark West Creek watershed, including Copeland Creek, Laguna de Santa Rosa, Austin Creek, Brush Creek, Mtanzas Creek, Oakmont Creek, Paulin Creek, Peterson Creek, Piner Creek Rinconada Creek, Santa Rosa Creek, Sierra Park Creek, the Mark West Creek mainstem, and Windsor Creek (Table 1). In creeks where natural waterways maintenance activities disturb aquatic habitat when listed salmonids are present, SCWA will relocate listed salmonids (juvenile steelhead and perhaps Chinook salmon).

NMFS anticipates that nearly all salmonids will be relocated once per year from areas of 50 lineal feet or less in those creek's natural waterways described directly above. Because these waterways contain better habitat conditions than constructed flood control channels, larger numbers of juvenile steelhead will need to be relocated. Nevertheless, because the areas of fish relocation are small compared to the extent of natural channels in these creeks, the juvenile salmonids relocated are likely only a small percentage of the juvenile steelhead rearing in these creeks. Relocation is likely to result in injury or death to three percent of fish transported and released away from sediment removal work sites. A smaller percentage of listed salmonids are likely to remain in the work areas (those that avoid relocation efforts) and die during dewatering and other construction activities.

[73] Coho salmon may inhabit some tributaries of Mark West Creek upstream of the locations where they were found in the Mark West Creek mainstem in 2002. They are unlikely to be found in tributaries of the Laguna de Santa Rosa, or Windsor Creek (due to this creek's high temperatures and poor habitat conditions).

J. Central Sonoma Watershed Project Flood Control Reservoirs

These reservoirs operate passively, *i.e.*, they were constructed to require no operational activity. Maintenance activities at these reservoirs are, in most cases, unlikely to adversely affect salmonid habitat or salmonids. Sediments and vegetation are removed from the reservoirs periodically. Because no flow passes downstream of the reservoirs during these activities, habitat accessible to salmonids downstream is not impacted.

Spring Lake is drained for maintenance work approximately once every 12 years. SCWA does not anticipate draining the lake during the next fifteen years (SCWA 2008b).

K. Urbanization

Continued operation of the Dams to provide water downstream to SCWA diversion facilities will likely facilitate continued growth and development in Sonoma County and Marin County. As described above in the Environmental Baseline, urbanization can adversely affect salmonids and their habitats by increasing: 1) water withdrawal from streams, 2) stormwater runoff frequency and magnitude, 3) sediment, turbidity, and toxic chemicals in streams, 4) loss of riparian habitat, and 5) loss of stream channel complexity.

NMFS does not expect that the growth facilitated by the operation of the proposed project for the next fifteen years will have major impacts on listed salmonids or their critical habitats. Growth has slowed in both counties due to recent economic conditions and both counties have general plans that focus growth to areas already urbanized (Sonoma County 1998, Sonoma County 2005, Marin County 2007). For example, only 5 percent of undeveloped land (84 percent of the county) in Marin County is available for development. Adverse impacts to stream and riparian habitats in the next fifteen years related to growth are expected to be confined to small areas of the Russian River watershed and Marin County.

L. Interrelated and Interdependent Activities

1. Diversion Facilities

Generally, the SCWA proposes to continue to operate and maintain the diversion facilities at Mirabel and Wohler as done in the recent past. These activities have the potential to adversely affect salmonid habitat and salmonids. For example, the diversion will change instream flow patterns and may delay migrating salmonids. The effects that are likely to occur for the fifteen year duration of the proposed project are described below.

a. Effects to Habitat, Including Critical Habitat

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 3.2 stream miles 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. Water spills over the dam until it is about two-thirds inflated, then most of the flow passes through the ladders and associated bypass pipelines. Inflating the dam will also change the water level downstream until stable flows through the ladders and associated bypass pipelines are 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. The stream channel is also graded at this time to promote water infiltration to the subsurface water extraction facilities. These activities are likely to remove habitat complexity, increase sediment input to the river, and create conditions that could strand juvenile salmonids. Simplification of habitat through the removal of bar vegetation and larger cobbles is likely to reduce the suitability of juvenile steelhead habitat that could be utilized during the winter to escape high flows. Gravel grading at Mirabel also causes turbidity levels to increase in downstream reaches of the Russian River. During this process, SCWA constructs a berm to separate the river from the grading area. After grading the gravel bar, the berm is removed and turbid water is released downstream into the Russian River. SCWA monitoring of these action found turbidity levels of 37.6 Nephelometric units (NTU) for two hours that subsequently declined to 7.3 NTUs after three and a half hours. Scraping and removal of gravel at the Mirabel Bar is to an elevation below the low-flow water surface. A two percent slope is left to reduce the potential for disconnection of surface water that could cause juvenile stranding.

The infiltration ponds, which are isolated from the Russian River by levees, occasionally flood during storm events. During flooding events salmonids (and potential predators) may be trapped in the ponds as water levels recede. The infiltration ponds at Mirabel are less likely to flood during storm events than the ponds at Wohler. Both sets of ponds are predicted to overtop only during December through March.

Water diversion intakes at Wohler and Mirabel are screened to prevent fish entrainment. However, the screens at Wohler do not meet NMFS screening criteria. The screens at Mirabel only meet NMFS screening criteria for juvenile salmonids, but not fry. The currents created by operation of these diversions are likely to overcome the swimming ability of some salmonid juveniles and fry, with potential for their impingement on the diversion screens.

As described in the ***IV. Description of the Proposed Action***, SCWA will replace the rotary drum fish screens at Mirabel to meet NMFS criteria for screen openings. Replacement will entail temporary diversion of the Russian River around the site using coffer dams. SCWA anticipates it will require 5 to 7 years to design and construct this project element in coordination with NMFS.

We have also considered the effects of the inflatable dam on water quality. The SCWA monitored the DO of the Wohler Pool in 1999 and found that DO levels ranged from 6.7 mg/l to 9.0 mg/l – slightly lower than DO levels at the upstream control site. Initial distress symptoms for salmonids occurred at DO levels of 6.0 mg/l – 7.0 mg/l (Barnhart 1986, Hassler 1987, Bjornn and Reiser 1991). 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. However, 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, whether Wohler Pool is there or not. Increases in stream temperature are a significant concern for salmon and steelhead, as stream temperature affects their metabolism, behavior, and survival rate (Bjornn and Reiser 1991). Many streams in California are already at or near high temperature thresholds identified in the literature for salmon and steelhead. Artificial structures that exacerbate stream warming can turn good quality habitat into marginal habitat, and turn marginal habitats into poor habitats.

The aquatic habitat at the inflatable dam site does not provide good quality rearing habitat for salmonids, as described in the *Environmental Baseline.* When the dam is inflated, a 3-mile long pond like environment will be created in the Russian River. Pond conditions are likely to diminish the value of this reach as salmonid habitat, by: 1) preventing the establishment of emergent riparian vegetation, 2) reducing the ability of the river to cool at night (in the pond), and 3) improving habitat conditions for known salmonid predators (pikeminnow and smallmouth bass). Pools and riffles will also be inundated with inflation of the dam, further reducing habitat complexity.

The SCWA Diversion Facility uses a variety of chemicals for its water transmission system. Herbicides are used to control vegetation along access roads, anti-corrosion chemicals are used in the facilities piping, and chlorine (0.6 parts per million) is used to disinfect diverted water. Because of SCWA best management practices for chemical storage and use, such as storage of all such chemicals at least 250 feet from water, and de-chlorination prior to discharges, the risk of entry of these chemicals into salmonid habitat during normal operations is negligible. Accidental spills do have the potential to introduce chlorinated water to streams in the watershed. SCWA has added de-chlorination baskets and alerts to 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 SCWA's operation and maintenance center.

b. Effects to Species

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 dependant, with juvenile salmonids more vulnerable to stranding than adults.

Although salmonid stranding during dam inflation and deflation has not been documented, SCWA staff noted stranding of warmwater fish species in 2003. NMFS concludes that stranding of salmonids is possible, especially when the dam is inflated or deflated in the late spring when YOY steelhead juveniles are present. However, based on the information available (and described below), NMFS expects few juvenile steelhead would be adversely affected, no more than five. Chinook salmon juveniles are likely to be larger, better swimmers capable of avoiding dewatered areas. Similarly, coho salmon smolts (if any are present) are unlikely to be impacted.

Gravel bar grading will continue at a two percent slope to reduce the potential for disconnection of surface water that could cause juvenile stranding. In addition, SCWA proposes to relocate juvenile steelhead to avoid stranding them in areas that may become disconnected from main channel flows. Although no fish were captured during fish relocation activities in 1999, low numbers of steelhead have been found in this reach of the Russian River by boat electrofishing surveys (Corps and SCWA 2004). For example, five steelhead were found in the area inundated by the Wohler Pool in 2003 (SCWA 2004a). Densities of juvenile steelhead are likely limited in this reach during summer months because of high summer temperatures. We estimate that, based on similar relocation activities reviewed by NMFS, approximately 3% of juvenile steelhead present at the site are likely to be injured or killed during relocation efforts.

Increased turbidity caused by gravel grading at the diversion sites is not expected to reach a level or duration that will adversely affect juvenile steelhead because of the short duration (three to four hours) and low levels of turbidity associated with this activity. Short duration exposure of turbidity levels caused by channel maintenance actions is likely to reduce feeding, or habitat preference for a short period of time with juvenile fish resuming normal behavior and preferred habitat within a few hours. Decreased habitat complexity caused by grading may prevent some juvenile steelhead from finding suitable rearing areas near the dam site.

Flood flows that overtop the infiltration ponds are likely to trap salmonids in the ponds when flows recede. SCWA has captured Chinook salmon from the Mirabel infiltration ponds, and both Chinook salmon and steelhead from the Wohler infiltration ponds. As floodwaters recede, fish stranded in these ponds will perish without intervention. After each flooding event, the SCWA rescues fish from drying portions of the ponds using standard fish capture techniques. Those fish are then transported and released in the Russian River. Based on the reported number of Chinook salmon and steelhead rescued from Mirabel ponds and the relative number of Chinook salmon spawning in the mainstem above Mirabel (Corps and SCWA 2004), NMFS anticipates no more than 150 juvenile Chinook salmon will need to be rescued and relocated per year. Similarly, NMFS anticipates no more than 150 juvenile steelhead and 5 adult steelhead will need to be rescued and relocated per year. Fish relocation activities pose a risk of injury or mortality to rearing juvenile salmonids. Any fish collecting gear, whether passive (Hubert 1983, Hubert 1996) or active (Hayes 1983, Hayes *et al.* 1996) has some associated risk to fish, including stress, disease transmission, injury, or death. As described above, we estimate that only 3% of relocated fish are likely to be injured or killed during relocation.

Both fry and juvenile salmonids may become impinged on the fish screens at Wohler; whereas because of better screening only fry may become impinged at Mirabel. Fish held on screens by diversion flows are likely to be injured or killed depending on the strength of the flow through the screens. The most common injury is scale loss, which can put fish at risk for disease. Higher flows can cause greater body injury or mortality. Screw traps downstream of Mirabel have documented steelhead juveniles in the area during spring. NMFS cannot accurately estimate the number of steelhead juveniles that could become impinged, but expects the number will be relatively small compared to the size of the juvenile steelhead population migrating downstream. The flow into the diversions is limited and is likely to only attract juvenile steelhead swimming downstream along the bank where the diversions are located. Juveniles swimming in the main

current and near the opposite bank are unlikely to be adversely affected. Impingement is likely to occur for the next fifteen years at Wohler, and occur for the next five to seven years at Mirabel, until these fish screens are replaced.

Although most project details are not available for replacing the drum fish screens at Mirabel to avoid entrainment of steelhead fry, the information available indicates that diversion of the Russian River will be needed. Diversion to dewater the work area is likely to strand any juvenile salmonids present. Based on the project's timing, NMFS expects only juvenile steelhead are likely to be present. Fish survey information from this area of the Russian River indicates juvenile steelhead densities are low. NMFS assumes SCWA will relocate any juvenile steelhead present in the dewatered area. Based on juvenile density information for this area, NMFS expects fewer than five juvenile steelhead will need to be relocated.

Adults delayed by the inflatable dam are not expected to be harmed or prevented from spawning. Since adult steelhead migrate later than either coho salmon or Chinook salmon and the dam will be deflated during most or all of the steelhead run, there should be minimal delay of steelhead. SCWA has concluded that when the ladders are functioning, adult salmonids can locate and pass the fish ladders successfully (Corps and SCWA 2004). The creation of a notch in the dam's crest is likely to reduce delays of smolts that encounter the 3.2 mile long impoundment created by the dam. Analysis of fish passage in the Columbia River found that juvenile salmonids are attracted to surface-oriented spillways for passage (Christensen and Wielick 1995). SCWA has tested this approach at the inflatable dam and has found it effective in reducing smolt delay by about half Median delay is now about 2.4 hours, mean delay is 12.8 hours (Manning *et al.* 2005). Although delay is reduced with the notch, any delay may expose salmonid smolts to increased rates of predation. Yet, the precise amount of additional predation cannot be determined based on available information. NMFS does not expect that increase in predation of juvenile and smolting salmonids is having a large impact on salmonid numbers because the delay is short

Salmonid smolts may experience higher rates of predation in this area in the spring when the dam is inflated if salmonid predators congregate in the pool or just downstream of flow over the notched dam. NMFS assumes that the overall impact of this predation on Chinook is limited due to the relatively large run documented in the Russian River. The overall impact on steelhead may be similar. NMFS is concerned that predation rates on coho salmon smolts in this area may be high. However, coho salmon smolt numbers are likely low and predators may be targeting more abundant prey (Chinook salmon and steelhead)

The dissolved oxygen levels found in the impoundment are within acceptable ranges for salmonids. The small temperature increases documented in the Wohler pool in summers may put any juvenile steelhead in this area under increased physiological stress. However, summer water temperatures in this segment of the Russian River are naturally high and are unsuitable for extended residence by steelhead, with or without the pool.

Inundation of three miles of the main stem by the Wohler pool may further reduce rearing opportunities in this area of the main stem, increasing the chance that some juvenile steelhead may not survive their attempts to rear in this area. Based on the small amount of juvenile steelhead likely to be present, NMFS expects few juvenile steelhead will be adversely affected.

2. Wastewater Treatment

Project operations for purposes of water supply result in the diversion of approximately 65,000 acre-feet of water from the Russian River (Corps and SCWA 2004). A substantial portion of this water supply is consumed, eliminated as waste, treated as wastewater, and ultimately discharged back into the Russian River watershed or San Pablo Bay as treated effluent. Corps and SCWA (2004) state that eleven wastewater treatment plants (WWTPs) serve SCWA's primary and secondary water contractors, including contractors who divert water under SCWA's water rights. NMFS has reviewed the project BA's analysis (see Section 7.2 in Corps and SCWA 2004) of the effects of these WWTPs on listed salmonids in the Russian River watershed and in streams entering San Pablo Bay, and we agree that the expected risk to salmonids due to operations at these facilities is generally low.

Members of the Subregional Reclamation System (an association that does not include SCWA) are working to resolve existing water quality issues related to discharges from the SRSWRS to the Laguna de Santa Rosa. Their current options are to either improve the quality of treated effluent or move the point of discharge. The movement of the point of discharge will likely require future federal consultation with NMFS concerning the effects to federally listed salmonids.

a. Impacts to Habitat, including Critical Habitat

Wastewater discharges are controlled and scheduled under the established policies of the Water Quality Control Plan for the North Coast (NCRWQCB 1993). Water treated to the secondary level or better (as described in the *Environmental Baseline*) is discharged back into Jones Creek, Dutch Bill Creek, Mark West Creek, and the Laguna de Santa Rosa tributaries of the Russian River. While discharge schedules vary between treatment facilities, the WWTP generally limit their discharges to months with relatively high seasonal flows. 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 April 30. Under the permits filed with NCRWQCB, the identified treatment plants 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.

NMFS is not aware of contaminant issues associated with any of the WWTP discharges, with the exception of the SRSWRS. This latter facility is known to exceed standards for nutrient concentrations, which can cause low DO concentrations and algal blooms that can adversely affect stream pH in the Laguna de Santa Rosa. This stream is also listed under Section 303(d) of the Clean Water Act for having high levels of ammonium and low DO due to non-point source nutrient inputs from agriculture. Discharges that contribute to diminishing concentrations of DO in the Laguna de Santa Rosa potentially diminish the value of this stream as a migratory corridor for steelhead.

b. Effects to Species

Migratory impacts to steelhead would most likely occur during years in which stream flows are relatively low during April and May when steelhead smolts and presmolts emigrate from tributaries of the Laguna de Santa Rosa towards the ocean. Steelhead smolts and juveniles that are prevented from migration during low flow years may be forced to reside in unsuitable habitat in upstream areas of the Laguna. Upstream migration to cooler tributary areas may be possible for some juvenile steelhead, but those that do not migrate upstream may not survive due to low DO or lethal temperatures conditions during the summer months.

VII. 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. 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.

NMFS staff maintain regular contacts 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. NMFS has also tracked local issues such as proposed local riparian regulations in Sonoma County. Based on this information and these resources, NMFS does not believe, other than the impacts of ongoing actions such as agriculture, forestry, and urbanization that have been described and analyzed in the *Environmental Baseline*, additional cumulative effects are reasonably certain to occur in the action area during the next fifteen years. NMFS expects the impacts of the ongoing actions during the next fifteen years to be similar to the present day impacts on listed salmonids and PCEs of critical habitat identified in the *Environmental Baseline*.

VIII. INTEGRATION AND SYNTHESIS OF EFFECTS

In this biological opinion, we analyzed the effects to threatened and endangered salmonid species and critical habitat of 1) ongoing operations and maintenance of the flood control and water supply projects at CVD and WSD, 2) operations associated with the Corps' Don Claussen Fish Hatchery facility at WSD and the CVD fish rearing facility and associated angling for those hatchery fish, 3) stream channel maintenance activities in the Russian River, Dry Creek, and a group of streams (Zone 1A) in the vicinity of Santa Rosa and Rohnert Park, 4) maintenance of water levels in the Russian River estuary for the prevention of flooding, 5) operation of the hydroelectric facilities at WSD and CVD, and 6) other actions that are interrelated and/or interdependent with the above actions. The Action Area for this project includes the East Branch and main stem Russian River downstream from CVD to the Pacific Ocean, the 14.1 mile section of Dry Creek below WSD, the Zone 1A streams affected by channel maintenance activities, and other streams that both support Federally listed salmonids and are affected by physical maintenance of SCWA's water transmission system (*e.g.*, pipelines). In analyzing the impacts of the hatcheries, it was necessary for us to consider the effects on all streams accessible by steelhead in the Russian River watershed, because of the potential effects of straying hatchery fish. Our analysis concerns the effects of continued operations of the project in a manner similar to recent historic practices for an additional fifteen year period.

Our assessment has considered the effects of the project on three species known to reside in the project area: CCC steelhead, CCC coho salmon, and CC Chinook salmon and their critical habitats. For each species and their critical habitat, it is necessary to analyze the impacts of the project in the context of the environmental baseline. This baseline is the environmental conditions that have resulted from past, current and ongoing actions that significantly altered the quality and quantity of the species' habitat. Thus, we must evaluate the project's impacts on the survival and recovery of the species by adding the effects of the project to the existing baseline condition of the species and their habitats. Because salmonid species require distinct freshwater habitats at different life stages, we have considered potential project effects to each of the major life stages occurring in the riverine environment: adult migrations, adult spawning, egg incubation, fry stages, juvenile rearing, and juvenile outmigration to the ocean.

The effects analysis considered the effects of the proposed action on the species' habitats, including critical habitat, and individual fish and fish populations in the action area. Here, we assess the impact of these effects on the function and role of of critical habitat and the survival and recovery of listed species at the ESU and DPS scale. In evaluating the effect of the project on the function and role of critical habitat, we identified four primary constituent elements (PCEs) of designated critical habitat for the three listed salmonid species. These PCEs are freshwater migration corridors, freshwater spawning habitat, freshwater rearing habitat, and estuarine rearing habitat. Where appropriate, we have differentiated adult migration and smolt migration to better describe anticipated effects of project operations on the freshwater migration PCE. Analysis of impacts to listed species was done primarily by evaluating how project effects on habitat would likely affect the survivorship of each life stage in the species life cycle and the effect of these changes to sub-populations, the Russian River basin in total, and each salmon species' ESU and the CCC steelhead DPS. We considered changes in abundance, population growth rate, spatial distribution, and genetic and ecological diversity.

Below, we first examine whether, with implementation of the proposed action, critical habitat would remain functional to serve the intended conservation role of the species (or retain the current ability for the primary PCE's to be functionally established), and then we address the effects of the proposed action on the likelihood of the survival and recovery of listed species.

A. Critical Habitat

The proposed project will adversely affect designated critical habitat as the result of flow management at WSD and CVD, stream channel maintenance activities, and water level management in the river's estuary. The following assessment first examines the effects and implications of proposed flow management actions on critical habitat for each species. We then discuss the effects of estuarine water level management and the implications of channel maintenance activities on critical habitat for each species. We also consider the effects to critical habitat of the hydroelectric project operations and water diversions by SCWA. After discussing the effects of these distinct project activities on critical habitat, we consider the significance of the combined effects of these activities, baseline conditions, and cumulative effects on the function and role of critical habitats for the three listed species.

1. Flow Management Effects on Critical Habitat

We have found that the amount and quality of critical habitat in the main stem Russian River and Dry Creek is highly dependent on the levels of flow released from CVD and WSD. Proposed flood protection and water supply management operations enhance some PCEs, but others are substantially degraded.

The adverse impacts of the project's proposed flow management plan on critical habitat are partly due to SCWA's requirement to maintain the minimum flows stipulated in D1610. This state mandate requires SCWA to manage releases at CVD so that except during dry water years, 185 cfs is maintained at Healdsburg between April 1 and August 31 and 150 cfs is maintained from September 1 through December 31. Given the extensive water demands and diversions along the 65 river miles between CVD and Healdsburg, SCWA needs to release about 250 to 300 cfs from CVD to achieve the 185 cfs minimum requirement at Healdsburg. Likewise, D1610's minimum flow requirement of 125 cfs at Guerneville during summer, except for dry years, causes artificially elevated inflow to the Russian River estuary that causes the need for periodic breaching of the sandbar at the rivers mouth. That breaching results in impacts to estuarine dynamics and the loss of freshwater lagoon habitats important for rearing steelhead. The minimum flows required under D1610 hamper efforts to recover CCC steelhead and CCC coho salmon. With respect to Dry Creek, the D1610 minimum flow requirement of 80 cfs is at a level that creates extensive high current velocities that limits the availability of rearing habitat for coho salmon and steelhead. These flows hamper efforts to recover these species. However, unlike the main stem, flow releases from WSD are determined by both the requirements of D1610 and water demand that often exceeds D1610's 80 cfs minimum requirement for summer months.

a. Chinook salmon

We conclude that the management of flows released from CVD and WSD has substantially affected PCEs of critical habitat for Chinook salmon. However, those effects are either largely beneficial or of minor adverse consequence to the current condition of these PCEs. Elevated flows during September and October appear to increase the quality of migration corridors for Chinook salmon in both the Russian River main stem and Dry Creek. SCWA's adherence to D1610 flow requirements for November and early December ensure that stream depths and current velocities support the formation of ample suitable habitat for the spawning and egg incubation of Chinook salmon. During winter, flow management is likely not problematic for Chinook salmon because flood operations help to reduce deleteriously high flows associated with storm events. Winter stream flows in the main stem and Dry Creek are also largely dependent on inflow from unregulated tributaries. Flood operations in response to major runoff events result in releases as high as 5,500 cfs at WSD and 4,000 cfs at CVD, with resulting scouring of substrates in potential Chinook salmon spawning habitats in the approximately three mile segment immediately downstream of WSD and in the five mile segment of the upper main stem Russian River below CVD. However, during times of potential flooding, the Corps' operations actually limit the magnitude of high flows, especially at sites below the confluence of major tributaries such as below Pena Creek on Dry Creek and below the confluence of the Russian River mainstem and the East Branch. Reduction of flows during potential flood events appears to mitigate the adverse affects of high flows on Chinook salmon spawning substrates, and it likely helps to mitigate the erosion of stream banks thereby limiting impacts to both spawning and rearing habitats. Although most flood peaks are reduced by CVD and WSD, existing and proposed flood releases will contribute to channel forming flows at a frequency that maintains geomorphic conditions in downstream reaches. These channel forming flows are periodically needed to transport sediment, and flush fine sediment from spawning areas. Flow releases during late fall and winter should provide relatively good quality habitat for incubating Chinook salmon eggs, although in some years flood operations between November and late February will likely destroy a small number of incubating Chinook salmon eggs or alevins when high flow releases scour gravel substrates in the upper main stem Russian River below CVD and in the three mile segment immediately downstream from WSD. The management of flows at WSD and CVD during spring will likely provide only limited amounts of rearing habitat for juvenile Chinook salmon in Dry Creek and the Ukiah Valley segment of the Russian River, because the project's artificially high flows create widespread high current velocities that exceed the tolerance of rearing juveniles. However, the significance of this effect of flow management on rearing Chinook salmon is unclear because this population migrates to the marine environment during their first spring when stream flows are naturally high and largely determined by unregulated inflow from the river's tributaries and because the rearing PCE for the Central Coastal diversity stratum does not appear to be limiting the Russian River population of CC Chinook salmon.

b. Steelhead

We find that flow management of Lake Mendocino and Lake Sonoma primarily affects CCC steelhead critical habitat by limiting the value of the PCEs of freshwater and estuarine rearing habitats. The project's flow management has little adverse affect on the adult migration corridor

and spawning site PCEs, because this species migrates and spawns during winter and early spring when flows in the main stem and Dry Creek are generally high and largely dependent on inflow from unregulated tributaries. The project's flood management operations during winter months generally help to reduce deleteriously high flows associated with storm events that contribute to redd scour, fish stranding on banks and flood plains, and downstream displacement of fishes. We conclude that flows during winter and spring are conducive to successful steelhead spawning and egg incubation. Eggs of steelhead that successfully spawn in the gravels of the main stem or Dry Creek are likely to successfully hatch in areas where gravels are not embedded with excessive fines due to sedimentation.

In contrast to the limited effects on habitat for migratory and spawning stages, the project's proposed flow management at WSD and CVD during late spring, summer and fall has a clear effect on the availability of rearing habitat for steelhead in the 14.1 mile segment of Dry Creek, in the 34 miles of the upper Russian River immediately below CVD, and in the river's estuary. Although dam construction, channel maintenance, and land use activities have all affected the natural morphology and habitat conditions in Dry Creek, the magnitude of flow releases from WSD has the greatest influence on the ultimate value of Dry Creek as critical habitat for rearing steelhead and the extent to which Dry Creek is able to support production of that species. Existing data for Dry Creek suggest that the proposed sustained summer flows of about 100 to 150 cfs create widespread high current velocities that exceed tolerances of rearing juvenile steelhead. The relationship between stream flow in Dry Creek and available rearing habitat for steelhead is generally inversely related between flows of about 50 cfs and 175 cfs, with decreasing quantity and quality of habitat as flow increases. Consequently, under the proposed flow operations, only a very small portion of Dry Creek will be optimal quality rearing habitat for steelhead, much of the creek will not be functional rearing habitat. Likewise, proposed operations at CVD during seasonal low flows substantially affect the amount of critical habitat for rearing steelhead in the upper Russian River. As in Dry Creek, habitat-discharge relations in the upper mainstem are inversely related. Despite the fact that summer water temperatures are suitable for steelhead in 34 miles of the upper Russian River, at current and proposed flow levels of more than 250 cfs at Ukiah, the amount and quality of steelhead rearing habitat is very limited in this segment during the low flow season of normal water years. In diminishing the quality and quantity of existing steelhead rearing habitat in approximately 14 miles of Dry Creek and 34 miles in the upper Russian River, the project will appreciably reduce the ability of the critical habitat PCE for juvenile rearing in these areas to be functional and serve the intended conservation role for this species. As discussed later, the significance of this becomes apparent when the overall status of critical habitat for this species in the Russian River and the DPS is considered.

Because of the complex relationship between flow management and estuarine water level management, we discuss the effects of project flows on estuarine rearing habitat separately in Section VIII.A.2, below.

c. *Coho salmon*

We find that the proposed flow management at CVD will probably have little adverse effect on coho salmon critical habitat because of the timing of this species' migrations and the distribution

of juvenile coho salmon habitat. This species primarily migrates and spawns during early winter (December and January) when flows in the main stem are generally high and largely dependent on inflow from unregulated tributaries. Therefore, proposed flow management at CVD will probably have little influence on conditions (*e.g.*, stream depths and velocities) for upstream passage of adult coho salmon during their winter migrations. We also find that proposed operations at CVD will have little influence on the PCE of spawning critical habitat for CCC coho salmon, given that the Russian River population of this species typically spawns in Russian River tributaries. Similar to Chinook salmon and steelhead, any coho that may spawn in the main stem will likely encounter flow levels conducive to spawning and successful egg incubation, except in areas immediately below CVD during flood control operations (see Chinook salmon discussion above). Regulation of flow from Lake Mendocino during spring months will provide suitable conditions for the out-migration of coho salmon smolts. Flow releases from Lake Mendocino during summer and early fall will likely have minimal effects on PCE of rearing critical habitat for coho salmon, because summer water temperatures in the main stem Russian River below this reservoir are unsuitable for rearing juvenile coho salmon during most of the summer.

Proposed operations at WSD will likely have only minor adverse effects on PCEs of critical habitat for adult migrating and spawning coho salmon. However, it will have a substantial adverse affect on the PCE of rearing critical habitat for coho salmon in Dry Creek.

The project's proposed flow management will have little adverse effect on the adult migration and spawning stages of coho, because this species migrates and spawns during winter (primarily December and January), when flow in Dry Creek is largely dependent on natural inflow from unregulated tributaries and releases from WSD are generally suitable for salmon spawning except during flood operations. The project's flood management operations during winter months generally help to reduce deleteriously high flows associated with storm events that contribute to redd scour, fish stranding, and downstream displacement of fishes. Thus we conclude that proposed flow management at WSD during winter will generally be conducive to successful coho salmon spawning and egg incubation. Similar to the other salmonid species, the eggs of coho salmon that may successfully spawn in the gravels of Dry Creek are likely to successfully hatch in areas where gravels are not embedded with excessive fines due to sedimentation.

The project's proposed flow management at WSD between late spring and mid-fall will have a detrimental effect on the value of the PCE of rearing critical habitat for coho salmon for reasons similar to those described above for steelhead. Many factors influence the ability of Dry Creek to function as critical habitat for rearing salmonids (*e.g.*, stream gradient, channel morphology, quality of substrate, availability of cover, water quality, depths, *etc*.); however, the ultimate value and proper functioning of Dry Creek as critical habitat for rearing coho and the extent to which Dry Creek is able to support production of coho is heavily influenced by the level of flow released from WSD. Existing data suggest that the proposed sustained summer flows of about 100 to 150 cfs create widespread high current velocities that support negligible levels of suitable habitat for rearing juvenile coho salmon. Similar to rearing habitat for steelhead, the relationship between stream flow and available rearing habitat for coho salmon is generally inversely related. However, rearing juvenile coho salmon are even more dependent on low velocity habitats than

steelhead (Hartman 1965; Sheppard and Johnson 1985). With the implementation of the proposed project and status quo flow releases from WSD, the PCE of critical habitat for rearing juvenile coho would not function to serve the intended conservation role for coho salmon in the mainstem of Dry Creek. The significance of this becomes apparent when the overall status of the PCE of freshwater rearing critical habitat for coho salmon in the Russian River and the ESU is considered.

Rearing habitat for coho salmon is very limited in the Russian River basin. Recovery of CCC coho salmon in the Russian River will very likely be dependent on the protection, restoration, and enhancement of limited available rearing habitats for this species. Coldwater releases from the bottom and middle strata of Lake Sonoma have created a unique, large stream of coldwater with water temperatures near optimal for juvenile coho salmon, a species that needs especially cold water to survive. Although these releases are made at temperatures conducive to coho rearing, water velocities in Dry Creek are generally too high for coho juveniles to find much in the way of useable rearing habitat in Dry Creek. NMFS estimates that the project's proposed flows will appreciably diminish the quality and quantity of existing coho rearing habitat in approximately 13 miles[74] of Dry Creek and thereby reduce the amount of the highly limited critical rearing habitat needed to sustain the Russian River coho salmon population.

It might be argued that the effects of the summer flow releases at WSD do not adversely modify critical habitat for steelhead and coho salmon or jeopardize the species because prior to the construction of the dam, the affected segment of Dry Creek had very limited rearing habitat due to naturally low summer flows (<1cfs) and following dam construction the relatively high regulated flows simply continued this condition of limited habitat in Dry Creek. Such an argument is based on the premise that maintaining a status quo of very limited critical habitat is all that is necessary to avoid a jeopardy or adverse modification finding. However, such an argument fails to recognize the need for the Action Agency to insure that the action is not likely to jeopardize listed species or result in destruction or adverse modification of critical habitat. The argument that constraining available rearing habitat for coho salmon and steelhead is acceptable because pre-development conditions in Dry Creek had limited rearing habitat does not address the fact that WSD and its related water supply functions have created a 14 mile long and approximately 30 ft wide segment of river with optimal coldwater temperatures and good quality substrates for juvenile coho salmon and steelhead. Abundant coldwater habitat (<18°C) was not present in this segment during summer months prior to the dam's construction, and now the elevated project releases very likely cause and facilitate the downstream displacement and subsequent mortality of significant numbers of juvenile steelhead and coho salmon (hatched in Dry Creek and emigrants from tributaries) that would otherwise occupy Dry Creek if flows were lower. It also does not recognize that summer rearing habitats for coho salmon are now very greatly limited in the Russian River watershed due to diverse public and private sector activities including the construction of WSD that blocked fish movements, road construction, channel maintenance, local timber harvests, agriculture, and both residential and urban development (including public regulatory and financial support). The coho salmon population in the Russian River has declined precipitously since construction of WSD in response to the reduction in the quantity and quality of rearing and spawning habitats throughout the watershed, and the

[74] the precise length is dependent on summer temperature-flow relations.

population will likely become extinct like the adjacent Walker Creek and Salmon Creek coho populations unless coldwater habitats for this species are restored or created. The Russian River coho salmon population is so low that maintenance of status quo conditions threaten the population through depensatory processes (*e.g.*, inability of few individuals to find mates) and inbreeding. By continuing to degrade a large portion of the existing coldwater habitat that some remaining coho salmon very likely attempt to use, the project helps insure the extirpation of coho salmon in the Russian River watershed, with deleterious consequences for the species. Likewise, the above development activities have significantly depressed numbers of steelhead in the watershed, and deeper coldwater rearing habitats for age 1+ juvenile steelhead are now limited in the watershed. The continuation of degraded conditions in the mainstem of Dry Creek is likely to limit the viability of the Dry Creek steelhead population by precluding a large portion of rearing juveniles from completing the species' life history cycle.

Opting for a "status quo condition" of very limited habitat in Dry Creek similar to pre-dam conditions also does not address the need to avoid diminishing the value of critical habitat needed for the conservation (*i.e.*, recovery) of the species. In this case, rearing habitat is extremely limited for coho salmon and substantially reduced for steelhead in the Russian River watershed. Under the proposed releases from WSD, the PCE of critical habitat for rearing steelhead and coho salmon would not be functional in Dry Creek. Maintaining the degradation of a large portion of the remaining rearing habitat will severely hinder the ability of coho salmon and steelhead to increase their numbers, distribution, and reproduction in the Russian River watershed, appreciably reducing the likelihood that these populations can be recovered.

2. <u>Estuarine Management Effects on Critical Habitat</u>

Proposed project operations will likely have significant effects on the PCE of estuarine critical habitat for each salmonid species because flow management at WSD and CVD will create high inflows to the estuary during the low flow season and the sandbar breaching activities at the mouth will significantly affect water quality in the lowermost segment of the river. The combination of artificially high flows entering the estuary during summer months and the proposed plan for breaching the estuary mouth is likely to result in the loss of productive freshwater rearing habitat at the mouth of the Russian River. This habitat is lost because the Russian River estuary will not remain closed long enough to form a freshwater lagoon during the low flow season in most years.

We conclude that effects on estuarine critical habitat for coho and Chinook will have minor consequences on the value of estuarine habitat for these species, because at the southern end of their ranges (e.g., the Russian River), juvenile coho and Chinook salmon generally do not reside in estuaries for extended periods, and their populations do not appear to be dependent on extended rearing in estuarine or freshwater lagoon habitats. However, the disruption in the formation of a closed lagoon will perpetuate the loss of habitat for an important life history component of steelhead in the Russian River watershed. The trapping of thousands of YOY steelhead in the Russian River near the Mirabel Rubber Dam and in lower Austin Creek demonstrates that large numbers of juvenile steelhead migrate downstream towards the estuary every year. The continued cycling of the estuary as an open and closed system from late spring through early fall will perpetuate dynamic water quality conditions that include episodes of

depleted oxygen levels and relatively high salinity that is not conducive for the survival and growth of young-of-year and age 1+ steelhead. Under recent historic practices, most young steelhead are unlikely to survive in the estuary.

Information from other estuaries and lagoons indicates that steelhead juveniles that rear in lagoons are a substantial portion of returning adult spawners. Conservation of the Russian River steelhead population is likely to depend, in part, upon an estuary that can support large numbers of rearing juveniles (tens of thousands) with good growth rates that promote better chances of their returning from the ocean as adult steelhead migrants. As described in the Status of the Species, the Russian River watershed is a key component of the CCC steelhead DPS. It is unlikely the DPS can be conserved without a successful conservation of Russian River steelhead populations.

3. Flood Channel Maintenance Effects on Critical Habitat

With respect to the project's proposed flood management maintenance activities in the main stem Russian River, Dry Creek, and the flood channels and natural waterways within SCWA's Management Zone 1A, we conclude that the proposed practices will not appreciably degrade the value of critical habitat for listed salmonid species in the main stem and Zone 1A. However, the anticipated erosion control practices along the banks of Dry Creek are likely to degrade PCEs of critical habitat for the rearing, spawning and migration of all three listed salmonid species. The proposed gravel bar grading in the river's main stem will be done in a manner that may increase sedimentation and degrade the quality of pool habitat along the river's thalweg (*i.e.*, deepest part of the channel). Vegetation maintenance at these main stem sites will reduce the availability of velocity refuges for fish during high flow events. The extent of channel maintenance activities on the main stem will be confined to not more than 4000 feet of river during any one year, and the activities will be implemented with a series of measures to minimize adverse effects to aquatic habitats. Channel maintenance activities in Zone 1A will largely concern stream segments not known to support coho salmon and not listed as critical habitat for either steelhead or Chinook salmon. Most of the work done in Zone 1A will consist of channel maintenance activities in flood control channels in segments of urban streams that are already heavily channelized and that provide either no or, at best, marginal quality habitats for listed species. Channel Maintenance activities in both flood control channels and in natural waterways in Zone 1A will be limited to activities during summer low flow conditions and limited to situations that pose a significant and demonstrated flood potential during upcoming seasonal storms. In Dry Creek, channel maintenance will consist largely of the maintenance of existing structures, vegetation removal, and possible placement of rip-rap at points of bank erosion. The placement of rip-rap will contribute to armoring the stream bank to the detriment of native riparian vegetation, with resulting degradation of areas providing velocity refuge during high flow events. Placement of rip-rap along the banks of Dry Creek will also contribute to simplifying the stream's channel morphology, with losses of complex pool and riffle sequences, and it will likely reduce the riparian forest canopy that shades Dry Creek during hot summer months.

4. Water Diversion Facility and Hydroelectric Project Effects on Critical Habitat

We find that operations of the water diversion facility at Mirabel and Wohler and the maintenance of the offstream water transmission facilities (*i.e.*, piping) for the water transmission system have minimal effects on critical habitat for listed salmonid species. The current waste water discharges that occur as the result of water diversions associated with the project have minimal adverse effects on critical habitat for listed salmonid species, although high nutrient levels pose some potential adverse affect on steelhead in the Laguna de Santa Rosa, a stream that was not designated as critical habitat. We also conclude that the hydroelectric operations at CVD and WSD are not likely to adversely affect critical habitat for salmonids because they will not determine the stream flows released from the project, but rather they generate electricity based on releases of water for other purposes. The quality of water discharged by the hydroelectric facilities is suitable for salmonids.

5. Summary of Project Effects on Critical Habitat

The above analysis identifies several ways in which the proposed project operations will affect the quality and quantity of PCEs of critical habitat for coho salmon, Chinook salmon, and steelhead. Because adult fall run CC Chinook salmon primarily migrate to spawning habitats during mid to late fall and the resulting progeny migrate downstream to the ocean during the following spring, flow management at WSD and CVD does not have significant adverse consequences for this species. Migrations of adult Chinook salmon appear to actually benefit from the elevated regulated flows during fall months, and rearing juveniles do not contend with the artificially high summer flows that limit available rearing habitat for the other Federally listed salmonid species. Although channel maintenance activities will likely have some adverse effect on spawning and rearing habitats for Chinook salmon, these effects will probably be minor because each year, channel maintenance will affect only a small portion (1.5 miles) of the 94 mile long main stem Russian River. This 94 mile segment effectively supports rearing habitat for juvenile Chinook salmon along its entire length and spawning habitat at riffles along the approximately 58 mile segment upstream from Healdsburg. Ongoing channel maintenance activities in Dry Creek will likely diminish available rearing habitat for Chinook salmon; however, the extent of habitat loss for rearing Chinook salmon in Dry Creek due to ongoing channel maintenance activities is likely minor given the availability of rearing habitat for this species throughout the main stem Russian River. We conclude that, if the proposed project is implemented, critical habitat for Chinook salmon would remain functional to serve the intended conservation role for this species.

In contrast to Chinook salmon, the proposed project will likely have significant adverse effects on the critical habitat of steelhead and coho salmon. With these effects, critical habitat for steelhead and coho salmon would not be functional to serve the intended conservation role for these species. Proposed flow releases from WSD and CVD during the approximately six-month long, low flow season will create excessively high current velocities that will greatly limit the value of 14 miles of Dry Creek and 34 miles of the upper Russian River as rearing habitat for steelhead. Flow management at the project's reservoirs and breaching of the estuary's bar will also adversely affect the value of steelhead rearing habitat in and near the vicinity of the estuary. Flow releases from WSD during summer and fall months will be so high that available habitat

for rearing juvenile coho will be minimal. Proposed continued channel maintenance activities in Dry Creek will contribute to armoring the stream banks, reducing velocity refuge areas for fishes during high flows, and simplifying stream channel morphology with potential degradation of both summer and winter rearing habitats for steelhead and coho salmon. The significance of these impacts to critical habitat for rearing steelhead and coho salmon becomes apparent when the status of critical habitat for these species is considered.

Our review of the status of populations of CCC steelhead in the Russian River indicate that freshwater rearing habitat is one of the two primary PCEs of critical habitat that are most degraded in the Interior and North Coastal Diversity Strata. The entire Interior stratum and a major portion of the North Coastal stratum are within the Russian River watershed. In these areas, degradation of steelhead rearing habitat is due to channel modifications, chronic deposition of fine sediments, and intensive diversions of surface flow in tributaries. The successful recovery of populations of steelhead within the Interior and North Coastal Diversity strata will depend upon the restoration of good quality freshwater rearing habitats, including ecologically diverse habitats such as freshwater lagoons and deep main stem habitats for older age 1+ and 2+ fish. Recovery of these diversity strata will, in turn, substantially improve the chances for the recovery of the CCC steelhead DPS. However, as proposed, the project's flow management plan (*i.e.*, conformance with D1610, water supply releases, and water level management in the estuary) will hamper efforts to recover this species by degrading and, in some cases, eliminating important freshwater rearing habitats in the upper mainstem Russian River, the river's estuary, and in Dry Creek.

Likewise, the availability of rearing habitat for coho salmon has been greatly reduced in the Russian River watershed and elsewhere as the result of numerous developmental activities. Coho salmon require especially cold water in which to rear, and developmental activities have undoubtedly limited the availability of such coldwater habitats. As discussed in the Effects Section, approximately 13 miles of Dry Creek provide temperatures that sustain rearing coho salmon; however, high flow releases from WSD during summer and fall months greatly limit the value of the PCE of critical habitat for rearing coho salmon. The proposed project operations appreciably degrade the value of critical habitat for CCC coho salmon. Successful recovery of this species will very likely require protection, restoration, and enhancement of existing rearing habitats for this species. Given that the Russian River is the largest watershed occupied by CCC coho salmon and that it is centrally located in this ESU, it is unlikely that the CCC coho can be recovered without a successful restoration of coho salmon runs in the Russian River.

B. Species

The proposed project has the potential to affect one or more of the following salmonid population viability criteria: population abundance, population growth rate (*i.e.*, productivity over the entire life cycle), spatial structure, and diversity. The following discussion separately addresses the effects of the project on these criteria for each of the three listed salmonid species that occur in the action area. From that analysis we are able to assess the project's risk to the likelihood of the survival and recovery of the species.

1. Project Effects on Chinook Salmon Survival and Recovery

Based on our analysis of the project's effects on critical habitat for Chinook salmon and the species' increasing population trend, we conclude that the proposed project will not adversely affect the abundance and population growth rate of Chinook salmon in the Russian River. The population has experienced generally positive growth over the past ten years and we reason that the likelihood of the Russian River Chinook salmon population's persistence is high. The project and interrelated or interdependent activities will likely injure or kill some individual Chinook salmon. For example, the water intakes at Wohler diversion facility do not meet NMFS screening criteria, and therefore some juvenile Chinook salmon are likely to be either impinged on the diversion screen or entrained through the screen into the diversion intake. It is also possible that a few juvenile Chinook salmon may be stranded when the Mirabel inflatable dam is deflated or when flood flows trap fish in the project's infiltration ponds. Likewise, sedimentation of gravels caused by project channel maintenance for flood protection in the main stem may annually cause some loss of good quality spawning habitat, with resulting loss of incubating eggs or alevins. We anticipate that these losses to Chinook salmon will be relatively minor to the population and not adversely affect the population's growth rate because they likely concern only a very small portion of the total egg, alevin, and juveniles produced in the river. The Russian River Chinook salmon population has maintained a positive growth rate despite these ongoing losses and continuing them for fifteen more years should not appreciably reduce the species chances for survival or recovery.

We also do not expect the project to adversely affect the spatial structure or genetic diversity of the Russian River population of Chinook salmon during the fifteen year life of the project, given that the project does not cause significant adverse effects to the species habitat, and the project will maintain the same conditions that have supported the recent growth of the Chinook salmon population. We have no reason to expect that the project will cause additional impediments that might further limit the species distribution or appreciably affect the ecological or genetic diversity of this population of Chinook salmon.

2. Project Effects on Steelhead Survival and Recovery

With respect to steelhead, we do not anticipate that the project will appreciably decrease the abundance of steelhead populations in the Russian River watershed relative to recent population abundances, because summertime flows in the main stem, Dry Creek and the river's estuary have been artificially elevated for decades and the proposed operations will result in flows that approximate those historic conditions. Many tributaries of the Russian River that are unaffected by the proposed project will continue to provide functioning, albeit degraded, steelhead rearing habitat, and several thousand wild steelhead will continue to annually return to spawn in the Russian River watershed during the fifteen year life of the project. The Don Claussen Fish Hatchery will also continue to contribute to the abundance of steelhead in the watershed through the production and stocking of hatchery fish that are genetically similar to wild stock and are listed as part of this DPS themselves. Despite the fact that the proposed project will probably not reduce the abundance of steelhead relative to recent historic numbers, the project will adversely affect the functionality of the PCE of freshwater rearing habitat for steelhead in 34 miles of the upper Russian River, 14 miles of Dry Creek, and the river's estuary, with resulting mortality of

juvenile fish (as described in the Effects Section). As a result, production of juvenile steelhead will be low in these potentially productive, major areas of the watershed. Because of the degradation of the critical rearing habitat and the fact that steelhead rearing habitat is limited in the Russian River watershed, we conclude that the project plays a substantial role in maintaining Russian River steelhead populations in abundances that are dramatically reduced from those found in the early and mid 1900s.

All of the populations of steelhead in the Russian River have exhibited negative growth rates over the past several decades as the result of diverse impacts to their environment. The project's flow management plan influences the growth rates of these populations because it directly affects both the available rearing habitat and potential production of steelhead in Dry Creek, the upper Russian River, and the lower river near, and in, the estuary. Each of these populations is adversely affected by the ongoing degradation of rearing habitat for juvenile steelhead due to the elevated inflows to the estuary and ongoing water level management practices in the river's estuary. The Dry Creek population, which was the largest potentially independent steelhead population occupying a single Russian River tributary, has experienced a significant negative trend over the past 25 years as the result of the construction of WSD, summer flow releases from that dam, and channel modifications in Dry Creek that combined have resulted in poor survival and growth of juvenile steelhead. Yet despite the migratory barrier presented by WSD, the Dry Creek watershed below that dam continues to be large enough to support a potentially independent population of steelhead (Spence *et al*. 2008). Any future flow management plan for the waters stored in Lake Mendocino and Lake Sonoma will affect growth rates in this population and other steelhead populations in the Russian River watershed. As proposed, the flow management plan will perpetuate status quo flows that strongly influence habitat suitability while the steelhead populations in the watershed experience negative growth trends due to other diverse developmental activities throughout the watershed. Elevated inflows to the estuary, the upper mainstem, and Dry Creek during the low flow season, and channel maintenance activities will continue to suppress populations of steelhead in the basin and not contribute to recovery; instead populations of steelhead will likely continue to decline through degradation of habitats stemming from status quo project operations and diverse non-project related activities. Alternative flow regimes in the Russian River and Dry Creek during summer and early fall have the potential to promote recovery by increasing steelhead abundance and population growth rates.

The proposed project will also maintain longstanding conditions that constrain the ecological diversity of the steelhead populations. As discussed in Baseline Section V.B.3, steelhead populations have diverse life history strategies, and in California, a significant component of many steelhead populations rear in productive freshwater lagoons. Indeed, juvenile production in freshwater lagoons can account for a large portion of the adults that return from the ocean to California streams. The proposed flow management plan and estuarine water level management will adversely affect the ecological diversity of steelhead populations in the Russian River watershed by continuing to suppress this component of the steelhead population's life history strategy.

We do not expect the project to cause any further adverse change in the existing spatial distribution of steelhead in the Russian River because the proposed project operations have been

ongoing in this form for many years, and any reductions in the spatial distribution of the species due to ongoing operations have very likely already occurred and will remain as a result of continued operations for the next fifteen years. We also note that steelhead remain widespread, albeit in low numbers, in the project area including the main stem, Dry Creek below WSD, and the river's estuary. We do not expect the project will cause additional impediments that might further limit the species distribution of steelhead.

With respect to the steelhead hatchery program at DCFH and the CVFF, the Steelhead Mitigation Program is currently a mitigation hatchery program, mitigating for salmonid habitat and production losses above Warm Springs and Coyote Dams. Although there is a potential to use these hatchery steelhead for recovery purposes, the program is currently only a mitigation program. The steelhead hatchery program does not offset losses of steelhead downstream from WSD. The primary objective of the ESA is the conservation of species in their natural ecosystems. The ESA mandates the restoration of threatened and endangered species in their natural habitats to a level at which they can sustain themselves without further legal protection (NMFS 1992). For Pacific salmonids, the ESA's focus is therefore on natural populations, the progeny of naturally spawning fish, and the ecosystems upon which they depend (NMFS 1992). Therefore, hatchery produced fish can not be relied upon to minimize or offset project impacts in the Russian River basin. The costs and benefits of the steelhead hatchery program can not be precisely determined, given the incidental capture of wild steelhead in the sportfishery for hatchery steelhead, the absence of a Fishery Management and Evaluation Plan for that sportfishery, and the fact that the hatchery fish are a part of the CCC steelhead DPS. However, it is known that there are no substantial genetic differences between wild and hatchery propagated steelhead in the basin, and therefore, continued exclusion of wild steelhead from hatchery spawning stock could result in a divergent hatchery population with reduced genetic diversity and increased inbreeding. The stocking of hatchery smolts may have some adverse effects to wild populations through their predation or competition with wild fish. We believe those effects are relatively minor, because hatchery fish are stocked only into Dry Creek and the East Branch (near the confluence with the upper main stem Russian River) when they are in a migratory stage and not acclimated to survival in the wild, and most migrate within a few weeks to the ocean. The hatchery program also promotes a fishery for marked adult hatchery fish in the mainstem Russian River. That fishery results in the capture (with barbless hooks) and release of wild steelhead, coho salmon, and Chinook salmon.

3. <u>Project Effects on Coho Salmon Survival and Recovery</u>

Almost all of the current production of coho salmon in the Russian River watershed is sustained either by artificial production and planting of wild stock coho salmon via the RRCSCBP or by remnant natural spawning in a few stream segments that are not within the action area. Because of the extremely small size of the Russian River coho salmon population and other coho populations in the coastal diversity stratum, the RRCSCBP will likely remain an essential factor in maintaining the abundance, spatial distribution, and genetic diversity of coho salmon in the river's tributaries until sufficient good quality habitats are restored or established. However, the efficacy of this program and prospects for achieving a viable population of coho salmon in the Russian River is threatened by the absence of an emergency water supply line for the DCFH and by the absence of funding commitment for the genetics management and field monitoring

components of the RRCSCBP. Spawning of wild adult fish likely occurs in only a few Russian River tributaries, including probably Dry Creek.

We anticipate that the proposed project's flow regime will probably not directly reduce the abundance of wild spawned coho salmon in the Russian River watershed relative to their recent abundance, because wild spawned coho fry will be exposed to the same adverse conditions and experience the same rates of mortality as other year classes of coho in recent previous years. However, the project's flow releases from WSD will perpetuate for an additional 15 years, conditions that adversely affect the functionality of critical habitat for rearing coho salmon in about 13 miles of Dry Creek and the river's estuary. Juvenile coho that originate from adult spawning in Dry Creek or that emigrate from tributaries to Dry Creek are likely to be displaced downstream into the main stem Russian River because available rearing habitat is limited by elevated summer flow and ongoing channel maintenance. We anticipate that most age 0+ juvenile coho salmon that are displaced downstream from Dry Creek will die as the result of predation or adverse conditions (*e.g*., elevated temperatures in the mainstem, or high salinity in the estuary). This anticipated continued loss of juvenile coho salmon due to high flow releases will reduce the abundance of the Russian River coho salmon population, which has exhibited a precipitous decline over the past several decades and is currently at a critically low level. As discussed above, this population is so low that maintenance of status quo conditions threatens the population through depensatory processes and inbreeding. Given that flows in Dry Creek and inflows to the estuary strongly influence the survival and abundance of juvenile coho in the Russian River watershed, any future flow management plan for the waters stored in Lake Sonoma will affect growth rates in this population. The project's flow management plan influences the spatial structure of the coho salmon population because, as proposed, it virtually precludes Dry Creek as useable rearing habitat for the production of juvenile coho salmon in Dry Creek. In the Russian River watershed, remnant runs of coho are largely confined to tributaries entering the lower river (*e.g*., Green Valley Creek and Dutchbill Creek). Coho salmon returns to the Dry Creek watershed are almost exclusively limited to fishes stocked in Mill Creek by the wild broodstock hatchery program.

The Russian River coho salmon population has declined to very low numbers. As such, the genetic diversity of the population is vulnerable to ecological depensatory processes that increase the risk of the population becoming extirpated. Depensatory processes include the inability of potential mates to find one another, and increased predation rates when predators are unsatiated. Discussing this issue McElhany *et al*. (2000) state, "Environmental variation can cause small populations to go extinct when chance events reduce survival and fecundity to low levels for an extended time. The genetic processes that may affect small populations include diversity loss, inbreeding depression, and the accumulation of deleterious mutations." In maintaining ongoing operations that constrain growth of the population, the project is contributing to the population's vulnerability to ecological and genetic processes that are likely reducing the genetic diversity of the river's coho salmon population. Given the central location of the Russian River in the range of CCC coho and that the watershed represents a third of the ESU by area, the survival and recovery of CCC coho salmon will likely depend on a substantial positive trend in the growth rate and abundance of coho salmon in the Russian River.

4. Summary of Project Effects on Species Survival and Recovery

In summary, we conclude that the proposed project operations are not likely to appreciably reduce the likelihood of CC Chinook salmon survival and recovery in the Russian River. We make this conclusion because the project is unlikely to reduce the abundance of spawners, the growth rate, spatial structure, or genetic diversity of the Russian River population of Chinook salmon. We base this finding on the following facts: 1) the population has experienced a generally positive growth over the past ten years, 2) the project does not cause significant adverse effects to the species habitat, and, 3) the project will maintain the same conditions that have supported the recent growth of the Chinook salmon population. However, we also conclude that, unlike the situation for Chinook salmon, the proposed project will likely have substantial adverse effects on both the coho salmon population and several steelhead populations in the Russian River watershed. The proposed flow management plan for CVD and WSD, the water level management plan for the river's estuary, and the ongoing channel maintenance activities in Dry Creek substantially influence the abundance, growth rate, and spatial structure of populations of steelhead and coho salmon in the Russian River. We find that the proposed project adversely affects these fundamental factors governing the viability of these salmonid populations. As proposed, the flow management plan will perpetuate status quo flows that strongly influence habitat suitability while the steelhead populations in the watershed experience negative growth trends due to other diverse developmental activities throughout the watershed. Elevated inflows to the estuary, the upper mainstem, and Dry Creek during the low flow season, and channel maintenance activities will continue to suppress populations of steelhead in the basin and not contribute to recovery; instead populations of steelhead will likely continue to decline through degradation of habitats stemming from status quo project operations and diverse non-project related activities. Alternative flow regimes in the Russian River and Dry Creek during summer and early fall have the strong potential to promote recovery by increasing steelhead abundance and population growth rates. Given that the Russian River supports nine steelhead populations, including one functionally independent population and six potentially independent steelhead populations, and that the river's populations span two of the five diversity strata within the CCC steelhead, the survival and recovery of this DPS will likely depend on successful efforts to increase the abundance, spatial structure, diversity, and growth rates of Russian River steelhead populations. Likewise, given the central location of the Russian River in the range of CCC coho and that the watershed represents a third of the ESU by area, the survival and recovery of CCC coho salmon will likely depend on a substantial positive trend in the growth rate and abundance of coho salmon in the Russian River. The coho population is appreciably affected by the continued loss of juvenile coho that are likely displaced from Dry Creek due to high summer flows that limit habitat availability and by the continued channel maintenance practices that prohibit natural channel processes that create suitable rearing habitats for the species. Given that the coho salmon population is so low, water level management of the river's estuary also poses some risk to the species.

IX. CONCLUSIONS

After reviewing the best available scientific and commercial data, the current status of the species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS biological opinion that the continued operations of CVD and WSD for a fifteen year period in a manner similar to recent historic practices together with SCWA's proposed ongoing water diversions from the Russian River and its proposed stream channel maintenance activities, estuary management, and hydroelectric project operations at CVD and WSD are not likely to jeopardize the continued existence of threatened CC Chinook Salmon. However, we find that the continued operations of CVD and WSD in a manner similar to recent historic practices together with proposed Dry Creek channel maintenance activities and estuary management are likely to jeopardize the continued existence of threatened CCC steelhead and endangered CCC coho salmon.

After reviewing the best available scientific and commercial data, the current status of the critical habitat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS biological opinion that the continued operations of CVD and WSD for a fifteen year period in a manner similar to recent historic practices together with SCWA's proposed stream channel maintenance activities and estuary management are likely to adversely modify critical habitat for CCC coho salmon and CCC steelhead. It is NMFS opinion that the proposed project is not likely to adversely modify critical habitat for CC Chinook salmon.

X. REASONABLE AND PRUDENT ALTERNATIVE

Regulations (50 CFR § 402.02) implementing section 7 of the Act define reasonable and prudent alternatives as alternative actions, identified during formal consultation, that: (1) can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the agency's legal authority and jurisdiction; (3) are economically and technologically feasible; and (4) would, NMFS believes, avoid the likelihood of jeopardizing the continued existence of listed species or the destruction or adverse modification of critical habitat.

This biological opinion has found that the proposed Russian River Project jeopardizes the survival and recovery of CCC steelhead and CCC coho salmon, and that aspects of the project adversely modify the critical habitat for both of these species. We find that the proposed project will have a significant adverse effect on the PCE of summer rearing habitat for steelhead in 1) the Russian River estuary, 2) the East Branch and mainstem segment between CVD and Cloverdale, and 3) the segment of Dry Creek downstream of WSD. Project operations affect the survival of steelhead in these three areas, thereby perpetuating negative population growth trends and maintaining longstanding conditions that constrain the ecological diversity of steelhead populations. The proposed project's major adverse effect on coho salmon stems from the elevated summer flows in Dry Creek and the ongoing maintenance of one mile of channel that ruin the value of Dry Creek as rearing habitat for coho salmon, despite the highly unusual, long stream segment (9 miles) with optimal temperatures for rearing coho salmon. The progeny of any coho salmon that might spawn in Dry Creek or juvenile coho that emigrate from tributaries (*e.g*., Mill Creek, Wine Creek, Pena Creek) into Dry Creek will likely be displaced downstream with low chances for survival. We also found that the proposed project will diminish coho production or adversely modify this species' critical habitat in the estuary, but it will not do so in the upper mainstem Russian River, because water temperatures in the latter area exceed tolerance limits of coho salmon, regardless of the proposed project.

To avoid the likelihood of jeopardy to the species and adverse modification of critical habitat, NMFS has collaborated with the Corps and SCWA in developing a Reasonable and Prudent Alternative (RPA) for this project that is consistent with the intended purpose of the action, can be implemented consistent with the legal authority and jurisdictions of the Corps and SCWA, is economically and technologically feasible, and would avoid the likelihood of jeopardizing the continued existence of listed species or the destruction or adverse modification of critical habitat. This RPA involves implementation of the project as described in Section III of this biological opinion, with eight modifications and additional actions as described in Section X.A of this opinion. All eight modifications and additional actions must be implemented as part of one RPA. In summary, new or modified actions that will be part of the Russian River Water Supply and Flood Control Project will include:

1. SCWA will petition the SWRCB to change minimum bypass flows identified in D1610 for the mainstem Russian River and Dry Creek. SCWA will also complete all necessary environmental documentation and other activities within its jurisdiction to promote changes to D1610 minimum flow standards as identified in Section X.A.1.

2. SCWA will collaborate with NMFS and modify their estuary water level management in order to reduce marine influence (*i.e.*, high salinity and tidal inflow) in the estuary during the summer and promote a higher water surface elevation in the estuary for purposes of enhancing the quality of rearing habitat for age 0+ and 1+ steelhead. SCWA will monitor the response of water quality, invertebrate production, and salmonids in and near the estuary to water surface elevation management in the estuary-lagoon system.
3. The Corps and SCWA will implement and monitor on-the-ground enhancements of rearing habitat that will avoid adverse modification of critical habitat and appreciably increase the survival of juvenile salmonids in Dry Creek during both summer and winter months. To do this, SCWA and the Corps will enhance the quality and quantity of pool habitat along the 14 mile segment of Dry Creek and install boulder clusters to improve rearing habitat for steelhead and coho salmon in Dry Creek. These enhancements, which will ameliorate habitat conditions adversely affected by high summer flow releases, will be distributed at several locations along Dry Creek and the timing of their installation will be staggered to begin by Year 5 and be completed by Year 12. Because the initial design, permitting, and construction of this work will take up to five years to complete, SCWA will also restore or otherwise enhance rearing habitat for salmonids in tributaries that enter Dry Creek downstream of WSD or other Russian River tributaries supporting coho salmon and steelhead by the end of Year 3 covered by this opinion.
4. SCWA will investigate the feasibility of constructing a pipeline to deliver water from Lake Sonoma to the mainstem of the Russian River in order to reduce the adverse effects of relatively high flow releases from WSD on rearing habitat for coho salmon and steelhead. An assessment of bypass pipeline alternatives will enable SCWA to identify the best method to ensure water deliveries while meeting salmonid habitat needs in Dry Creek in the unlikely event that habitat enhancement efforts in Dry Creek are unsuccessful in supporting successful growth and survival of juvenile steelhead and coho salmon.
5. The Corps will strengthen the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) by conducting needed 1) annual genetics analysis and 2) annual monitoring of the distribution and survival of stocked juvenile salmon and the subsequent return of adult coho to the Russian River.
6. SCWA will implement expansion of the RRCSCBP to include the annual rearing and stocking of 10,000 coho smolts genetically managed via the wild coho broodstock program.
7. The Corps will install a new back-up water supply pipeline to the Warm Springs Hatchery, and complete construction of additional rearing facilities for the coho salmon broodstock program.
8. Consistent with recent historic monitoring efforts, SCWA will annually monitor the upstream migration of adult salmonids at the Mirabel Dam between late August and late fall, and they will annually monitor downstream migration of juvenile salmonids past the Mirabel Dam during spring and early summer for 15 years.

The following section describes the purpose, objective, methods and schedule of each project modification and new element of the Russian River Water Supply and Flood Control Project.

A. Project Modifications and New Project Elements of the Reasonable and Prudent Alternative

1. Pursue Changes to D1610 Flows

Purpose:
As described in this opinion, the proposed continuation of elevated flows in Dry Creek, the mainstem Russian River, and the estuary is likely to negatively affect the ability of salmon and steelhead populations to survive and recover in the Russian River watershed. High water velocities associated with the project's artificially elevated summer flows and stream channelization greatly limit the quantity and quality of juvenile salmon and steelhead rearing habitat in Dry Creek and the upper Russian River. Relatively high discharge also disrupts the normal processes of lagoon formation in the Russian River estuary, thereby exacerbating the potential for flooding of low-lying properties, and increasing the frequency of mechanical sandbar breaching.

SCWA's water right to operate the Russian River Project is permitted by SWRCB Decision 1610 (D1610). Changes to the D1610 flow minimum requirements will enable alternative flow management scenarios that would increase available rearing habitat in Dry Creek and the upper Russian River, and it would provide a lower, closer to natural inflow to the estuary between late spring and early fall, thereby enhancing the potential for maintaining a seasonal, freshwater lagoon that would likely support increased production of juvenile steelhead and salmon.

Objective:
Changing the minimum flow requirements mandated under D1610 will require an action by the SWRCB. The Corps and SCWA do not have the authority to change these minimum flow requirements; however, SCWA does have the ability to petition the SWRCB to change minimum flow requirements identified in D1610, and it has the ability to complete needed environmental and engineering documentation to support the petition to change flow requirements specified in D1610. The objective of this RPA element is to require all activities within the authority of the SCWA and the Corps to change minimum instream flow requirements in the Russian River and Dry Creek via the water rights petitioning process of the SWRCB. D1610 specifies that further fisheries investigations should be done in the Russian River and that such studies may assist in refining minimum instream flows. The SWRCB maintained jurisdiction to amend the Agency's water right permits if fisheries studies demonstrated that a flow schedule different from that outlined in D1610 would be beneficial. As described in the preceding biological opinion, data indicate that proposed Corps and SCWA operations maintain minimum instream flows that are excessive and limit conservation of listed salmonids. Reducing minimum flows mandated by D1610 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.

Methods and Schedule:

Changing D1610 will require a Petition to Change D1610 minimum flow requirement to the SWRCB, Public Notice of this Petition, completion of a multiyear EIR for compliance with California Environmental Quality Act (CEQA), and a hearing process before the SWRCB. This

process will require 6 to 8 years to complete. Before completing this process, SCWA will be obligated to maintain minimum flows stipulated under D1610 with resulting impacts to listed salmonids for up to eight years, unless temporary relief is provided. Temporary variance from D1610 is possible. Therefore, SCWA will seek both long term and interim changes to minimum flow requirements stipulated by D1610.

Permanent Changes to D1610

SCWA will begin the process of changing minimum instream flows by submitting a petition to change D1610 to the SWRCB within one year of the date of issuance of this final Biological Opinion. That petition will request that the SWRCB change stream flow requirements for the Russian River Basin such that minimum stream flows at certain locations will be reduced in the mainstem Russian River and Dry Creek between late spring and early fall during normal and dry water years as defined by water year criteria specified in D1610. Requested revised minimum flow criteria will promote goals of enhancing salmonid rearing habitat in the upper Russian River mainstem, the lower river in the vicinity of the estuary, and Dry Creek downstream of WSD. The revised minimum flows should promote water conservation and seek to limit effects on in-stream river recreation. Observations during the 2001 interagency flow-habitat study and during the 2007 low flow season, when flows at the Guerneville gage ranged from about 60 to 100 cfs, indicate that the following changes may achieve these goals:

During Normal Years:

1. Reduce the minimum flow requirement between the mouth of Dry Creek and the mouth of the Russian River from 125 cfs to 70 cfs.
2. 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.
3. 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:

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

The rationale for these suggested changes in minimum flow requirements is as follows:

As explained in Sections V.A.1 and VI.G.1b of this biological opinion, estuarine hydraulics and estuarine water quality dynamics are dependent on the magnitude of freshwater inflow, sediment supply, and wave action that promotes formation of a barrier beach (commonly referred to as a sandbar) at the river's mouth. Artificially high inflows during summer months interfere with normal processes that discharge river flow through or over the barrier beach to the ocean. Corps and SCWA (2004) estimate that predevelopment mainstem flows to the estuary often dropped to 25 cfs or less, and that prior to the Potter Valley Project, the estuary likely remained closed to the ocean for weeks or months at a time. The D1610 minimum requirement of 125 cfs at Guerneville during normal water years is much higher than the unregulated conditions that existed prior to construction of Lake Pillsbury and Lake Mendocino. Because the dynamics of

lagoon formation are dependent on several variables, including freshwater inflow, wave conditions, the quantity and quality of available sediment supply, and underlying geologic structure at the river's mouth, it is not possible to specify any one single inflow requirement that will promote lagoon formation. However, a lower flow requirement would promote long-term closure of the lagoon (*i.e*., a barrier beach across the mouth that isolates the lagoon from the ocean) or maintenance of a perched lagoon in which the river flows over the barrier beach, increasing lagoon depths and disconnecting the estuary from the ocean (eliminating the influx of saltwater) except for occasional wave overwash. A new minimum flow requirement of approximately 70 cfs at Guerneville would reduce the minimum flow requirement at Guerneville by 44%. Because SCWA maintains a 10 to 15 cfs buffer to avoid non-compliance of the minimum standard, a 70 cfs requirement would likely result in an inflow of about 80 to 85 cfs to the estuary. In the considerably smaller Carmel River estuary, a perched freshwater lagoon was maintained in 2005 at an inflow of about 60 to 70 cfs, and the Carmel River lagoon would likely accommodate higher inflows if the outlet stream over the barrier beach was moved to the northern side of the river's mouth (J. McKeon, NMFS, personal communication 2007). Informal observations and reports concerning recreational boating in the lower Russian River during summer 2007 indicate that flows of 80 to 100 cfs accommodate recreational canoeing and kayaking. Thus a minimum flow requirement of 70 cfs at Guerneville, with a 10 to 15 cfs buffer would appreciably enhance the prospects for achieving a closed or perched lagoon that would likely enhance salmonid estuarine rearing habitat, while conserving water and minimizing impacts to other river resources.

Reduction of the minimum flow requirement at the Healdsburg gage during normal years would enhance the quantity and quality of rearing habitat for steelhead in the river between the mouth of the East Fork and Cloverdale, the segment that typically supports suitable summer water temperatures for rearing juvenile steelhead. The 2001 flow-habitat assessment indicated that flows of about 125 cfs provided considerably more rearing habitat for steelhead in this segment than higher flows (190 and 275 cfs). In order for SCWA to comply with D1610 and maintain flows of 185 cfs between the East Fork and the mouth of Dry Creek, it is necessary for them to release approximately 250 to 300 cfs at CVD during summer months. Reducing this minimum requirement to 125 cfs would ensure that adequate flow is provided in the segment between the East Fork and Cloverdale (as documented in the 2001 flow habitat assessment). Moreover, it would likely enhance the quantity and quality of steelhead rearing habitat throughout this segment, while conserving the coldwater pool in Lake Mendocino. Conservation of that coldwater pool would increase the likelihood that waters released from that reservoir would remain suitably cool for rearing steelhead throughout the summer. It would also help ensure that sufficient flow could be released to facilitate upstream migration of fall run Chinook salmon.

Reduction of the minimum flow requirement for Dry Creek below WSD would allow SCWA to release lower flows at WSD during summer months. The 2001 flow-habitat assessment indicated that flows of about 50 cfs provided more rearing habitat for steelhead and coho salmon in this segment than higher flows (90 and 130 cfs).

In pursuing CEQA/NEPA compliance, SCWA may find alternative minimum flow requirements that meet the goals of restoring functional salmonid rearing habitat in Dry Creek, the upper

mainstem, and the estuary, thereby increasing population abundance and growth rates, while promoting water conservation and limiting adverse effects on other in-stream resources.

Within 6 months after the SWRCB's public notice that SCWA has petitioned for a change to terms and conditions of D1610, SCWA will begin the CEQA/NEPA process by issuing a Notice of Preparation/Notice of Intent. The SCWA's Board of Directors shall certify a final CEQA/NEPA document within four (4) years of filing the petition to change D1610. This would be five years after the issuance of this biological opinion. Upon filing the petition to change D1610, SCWA will conduct outreach with the support of NMFS staff to affected parties in the Russian River watershed. The SWRCB will very likely complete required staff review, public hearings, and issue an order to change flows following a one to two year period (seven to eight years after the issuance of this biological opinion).

The change of minimum required stream flows in the Russian River mainstem and Dry Creek is an essential RPA element for avoiding jeopardizing the continued existence of CCC steelhead and CCC coho salmon. Although the establishment and change of stream flow requirements is done under the authority of the SWRCB and not the SCWA nor the Corps, the likelihood that such changes can and will be accomplished within an eight year time frame is near certain because:

1. D1610 provides SWRCB with "*jurisdiction to amend SCWA's permit if a fishery study is conducted which shows that a different flow schedule would be better, or if further evidence otherwise becomes available which may affect the minimum flows*".
2. This biological opinion and referenced studies and reports strongly support reducing minimum stream flow requirements to protect and recover several important fish species in the Russian River and Dry Creek.
3. The fish species benefited by reductions in required minimum flows are both commercially important and listed under the Federal ESA. One of the species, coho salmon, is listed under CESA.
4. Throughout California, water supply is highly limited during summer and early fall. The Russian River is the only river in California where regulated flows that greatly exceed historic, unregulated levels are discharged to the Pacific Ocean during summer and early fall. Therefore, municipalities and other water supply interests will very likely support changes that help to avoid jeopardizing listed salmonids and at the same time reduce the amount of water that must be allowed to reach the Pacific Ocean.
5. This RPA element seeks to conserve the value of critical habitat for rearing steelhead and coho salmon in Dry Creek, the upper mainstem, and the estuary, while at the same time promoting water conservation and limiting adverse effects on other in-stream resources. Therefore, with few exceptions, the public-at-large will very likely support such changes.
6. During summer 2007 when stream flows were in the vicinity of 80 to 100 cfs, depths and velocities in shallow riffles were lower than when flows are between 140 and 180 cfs (more typical, recent summer flows in the lower Russian River). Nevertheless, during summer 2007, observations by NMFS staff indicate that recreational canoeing and kayaking was feasible and viable throughout the lower river (W. Hearn, NMFS, personal communication). Effects of the lowered minimum flows in 2007 on recreational boating were negligible in the several miles of river impounded by county summer dams (*i.e.*,

Vacation Beach dam, Johnson Beach dam, and the SCWA dam at Mirabel). Therefore, although recreational boating may be affected by reduced summer flows, the effect is likely minor and insufficient to cause SWRCB to reject a change in the minimum flow requirements currently stipulated by D1610.

7. SCWA has maintained vertical arrays of continuously recording water quality meters at several sites in the Russian River estuary since 2004. A multi-year comparison of dissolved oxygen and water temperature in the freshwater portion of the water column at two sites showed no differences that were attributable to the quantity of freshwater inflow (river discharge) to the estuary. For example, despite flows in the vicinity of 80 to 100 cfs during summer 2007, peak surface water temperatures at the middle estuary water quality monitoring site were lower than in 2006, a year with normal discharge (J.Church, SCWA, personal communication, July 2008).
8. In response to limited winter rainfall, dwindling water supply in Lake Mendocino, and anticipated impacts to fisheries, the SWRCB temporarily lowered minimum flows in the Russian River during summer months in 2004 and 2007. The SWRCB's support of lowered minimum flow requirements during these years demonstrates that agency's openness and willingness to modify D1610 flow requirements when provided defensible, supporting technical information.

In summary, with documented benefits to both fisheries and water supply from decreased minimum stream flow requirements in the Russian River, and the absence of significant water quality impacts of reduced flow requirements during 2004 and 2007, and past support of SWRCB in temporarily modifying (reducing) stream flow requirements in 2004 and 2007, it is highly likely that the SWRCB will act favorably towards SCWA's petition to reduce summer flow requirements in the Russian River and Dry Creek to address adverse effects of flow releases identified in this opinion. The SWRCB will have authority to change D1610 flow requirements following issuance of CEQA documentation and a public hearing process. We anticipate this will be accomplished between 2014 and 2016.

Temporary Urgency Changes

To help restore freshwater habitats for listed salmon and steelhead in the Russian River estuary, SCWA will pursue interim relief from D1610 minimum flow requirements by petitioning the SWRCB for changes to D1610 beginning in 2010 and for each year prior to the permanent change to D1610. These petitions will request that minimum bypass flows of 70 cfs be implemented at the USGS gage at the Hacienda Bridge between May 1 and October 15, with the understanding that for compliance purposes SCWA will typically maintain about 85 cfs at the Hacienda gage. For purposes of enhancing steelhead rearing habitats between the East Branch and Hopland, these petitions will request a minimum bypass flow of 125 cfs at the Healdsburg gage between May 1 and October 15. NMFS will support SCWA's petitions for these changes to D1610 in presentations before the SWRCB. Given the reservation of authority in D1610 and the fact that this BO constitutes substantial new information on fisheries in the Russian River that was not available to the SWRCB at the time D1610 was issued, and that the changes of flows outlined in this RPA are necessary to avoid jeopardizing the continued existence of the listed species, NMFS expects that the temporary urgency change petitions will be approved by the SWRCB on an expedited basis.

Reporting and Review:
Copies of the petitions to change D1610 submitted to the SWRCB will be sent to the NMFS Santa Rosa office. NMFS will be included on the mailing list for all public notices and documents related to the CEQA/NEPA compliance process. NMFS will be updated on the progress of this element of the RPA during Section 7 progress meetings and as public notices and documents are issued related to the petitions to change D1610 and the associated CEQA/NEPA process. NMFS acknowledges that unforeseen issues may arise during the water rights and CEQA/NEPA processes. The aforementioned schedule may be modified in consultation with NMFS based on proceedings for the petition to the SWRCB and the related CEQA/NEPA processes.

2. Alterations to Estuary Management

As described in this opinion, the proposed project is likely to result in Russian River estuarine conditions that negatively affect the ability of steelhead to recover in the Russian River watershed by limiting the number and life history stages of steelhead that can successfully rear in the estuary during spring, summer and early fall months. The biological opinion describes two main project elements that will likely cause these conditions, sandbar (*i.e.*, barrier beach) management at the estuary's mouth, and elevated inflows to the estuary from dam releases upstream.

Elevated inflows are addressed in RPA Element 1 above. This second RPA element is intended to modify barrier beach management to reduce its adverse effects on juvenile steelhead numbers and life history stages that rear in the estuary. This element also includes provisions for monitoring the response of water quality, invertebrate production, and salmonids in the estuary to the management of water surface elevations in the estuary-lagoon system.

Brackish/freshwater lagoons and sloughs elsewhere in California and the west coast are used extensively by emigrating smolts and rearing juvenile steelhead and Chinook salmon, as well as coho salmon smolts. A significantly deeper and stable brackish/freshwater estuary is likely more similar to the historic rearing environment for Russian River salmonids than conditions induced by frequent breaching and conversion to a marine environment. Adaptive management of the barrier beach, estuarine water levels, and outflow at the river's mouth is a reasonable and prudent approach to achieving flood protection and fish habitat goals. To achieve these goals it will be necessary to monitor biological productivity, water quality and physical processes in response to changes in management actions that control estuarine water levels.

2.1 Alternative Strategy and Approaches for Management of Estuarine Water Surface Elevations

Purpose:
As stated in Section VIII.A.2, proposed sandbar breaching activities at the mouth will significantly affect habitat conditions in the lowermost segment of the Russian River. When ocean waves build up a sandbar across the river's mouth, the Russian River estuary forms a lagoon that is hydraulically isolated from the marine environment, except for occasional wave

overwash. Freshwater inflow causes this lagoon to slowly gain in volume and depth. Similar to historic practices, the proposed breaching activities will cause the lagoon to return to a tidal system reconnected to the ocean and have a nearly marine salinity of >28 parts per thousand as far upstream as the mouth of Sheephouse Creek. These practices cause the estuary to become very shallow and subject to water quality dynamics that are neither natural nor optimal for the survival of large numbers of small, juvenile steelhead. The purpose of this element of the RPA is to enhance the quality of the Russian River estuary as rearing habitat for young-of-year and age 1+ juvenile salmonids.

Objectives:
SCWA will manage water surface elevations in the Russian River estuary by conserving beach sands and encouraging formation of a more extensive beach complex capable of forming an elongated and elevated outlet channel during the low flow season (approximately mid-May through mid-October) that will 1) maintain the estuary's water surface above the high tide line and 2) avoid flooding.

Estuary water level management targets will be:
1) A daily minimum water surface elevation of 3.2 feet during 70 % of the year. Absent river flood flows and the historic mechanical breaching practices, NMFS expects cross shore transport of sand by wave action will be sufficient to maintain the bar at this elevation.
2) An average daily water surface elevation of at least 7 feet from May 15 to October 15. NMFS expects the barrier beach to be this high or higher when the estuary closes in the spring, as a natural function of wave action and sand transport typical of spring and summer.
3) NMFS expects the lagoon will be breached open to ocean tides starting after October 15th if the estuary is perched or closed. Steelhead juveniles are expected to be large enough by mid-October to withstand salt water conditions.

These targets may be initially difficult to meet because NMFS expects past management has depleted sand supply to the north end of the beach, decreasing the width and elevation of the barrier beach. At first, this condition will constrain outlet channel length, elevation and stability. Over time NMFS expects RPA implementation will result in greater beach width and elevation, allowing formation of a more stable outlet channel capable of effectively maintaining the minimum water surface elevation targets.

Actions:
To achieve these objectives, SCWA will manage flood risk and estuary water surface elevation by adaptively managing the barrier beach and flood risk as follows:

2.1.1. <u>Adaptive Management of the Outlet Channel</u>

1a) Within six months of the issuance of this biological opinion, SCWA, with support from NMFS, shall conduct public outreach and education on the need to reduce estuarine impacts by avoiding mechanical breaching to the greatest extent possible.

1b) In coordination with NMFS, CDFG, and the Corps, SCWA will annually prepare barrier beach outlet channel design plans. Each year after coordinating with the agencies, SCWA will

provide a draft plan to NMFS, CDFG, and the Corps by April 1st for their review and input. The initial plan will entail the design of a lagoon outlet channel cut diagonally to the northwest. Sediment transport equations shall be used by SCWA as channel design criteria to minimize channel scour at the anticipated rate of Russian River discharge. This general channel design will be used instead of traditional mechanical breaching whenever the barrier beach closes and it is safe for personnel and equipment to work on the barrier beach.

1c) Alternate methods may include 1) use of a channel cut to the south if prolonged south west swells occur, and 2) use of the current jetty as a channel grade control structure (as described below) for maintaining water surface elevations up to 7-9 feet NGVD.

1d) If attempts to avert flooding using action 1b or 1c above fail to prevent a continued rise in the estuary's water surface level, flooding is imminent, and ocean conditions are such that repeated attempts to adaptively manage the estuary's water surface level described in 1b or 1c are not safely feasible, mechanical breaching may be used to breach the estuary as necessary to avoid flooding.

1e) If the barrier beach has not closed and the estuary's water surface level is not being maintained at >3.2 feet NGVD by June 15 of each year when river inflows should have receded to about 150 cfs, SCWA shall consult with NMFS and CDFG to consider the feasibility of changing the outlet location from the center of the beach to a longer more northerly outlet as described in 1b), and filling in the center outlet channel with sand from the beach. The change in channel configuration would likely need to be carried out at slack tide and may not be feasible under all hydraulic conditions in the outlet channel. Based on the feasibility of closing the sandbar mouth during the summer months and managing the estuary as a closed or perched estuary, SCWA will implement these changes.

NMFS, CDFG, and the Corps will be invited to observe implementation of the revised outlet channel design plan. An approximately one week notice will be provided.

Subsequent to the results of implementation, if needed, SCWA will revise the channel design plan in consultation with NMFS, CDFG, and the Corps. Adaptive estuarine water level and barrier beach management plans will be provided to NMFS, CDFG, and the Corps for their review, input, and approval by no later than April 1st in each year covered by this biological opinion.

2.1.2. Investigation of Jetty Impacts on Permeability and Lagoon Formation and Evaluation of Jetty removal

2a) If adaptive management of the outlet channel as identified in items 1b, 1c, and 1e above is not able to reliably achieve the targeted annual and seasonal estuary management water surface elevations by the end of 2010, SCWA 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. SCWA will consult with California State Parks, public trustee and manager of the beach at Jenner. If efforts identified in 1b, 1c, and 1e above are unable to achieve the estuary water surface elevation management targets, the study plan for the jetty will be submitted for NMFS and CDFG review and approval no later than June 30, 2011. SCWA will then conduct that study for which a report will be completed and submitted to NMFS and CDFG by no later than December 30, 2012.

2b) If the Jetty compromises the formation of a closed barrier beach in the spring and summer, and removal of the jetty does not appreciably increase flood risk, the Corps shall design a plan for removal of the jetty and fund its implementation.

2.1.3. Flood Risk Reduction

Because of the likely degradation of the barrier beach resulting from decades of mechanical breaching, and the effect of the jetty on beach permeability and barrier bar formation, it may be difficult to reliably achieve raised water surface elevation targets based on items 1b, 1c, and 1e above. Should those actions be unsuccessful in meeting estuarine water surface elevation goals, SCWA 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. Because raising public and private structures to avoid flooding damage associated with restoration of natural estuarine function may have no realistic reversibility, the following actions for this RPA element shall not be implemented unless all three conditions described in 3c below are met.

a) SCWA shall develop a 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. A completed list will be submitted to NMFS and CDFG within 18 months of the issuance of this biological opinion.

b) SCWA, shall identify possible funding mechanisms to provide grants or loans to property owners to avoid or mitigate damages to structures (by raising the structures or otherwise) that are commonly threatened by flooding when the estuary closes. For example, SCWA shall work with appropriate public and non-profit private agencies to identify, and if possible, obtain, funding assistance for avoidance and mitigation efforts.

c) If: 1) adaptive management of the outlet channel as identified in items 1b, 1c, and 1e above is not able to reliably achieve the targeted annual and seasonal estuary management water surface elevations by the end of 2013; 2) estuary monitoring indicates that freshwater or oligohaline (low salinity brackish) habitats, or temporary closure of the estuary provides substantial benefit to rearing juvenile steelhead similar to other closed lagoons on the California Coast; and 3) monitoring indicates no adverse impacts to other populations of Russian River salmonids are occurring from raised lagoon water surface levels; SCWA, in coordination with NMFS and other appropriate public and nonprofit agencies, shall, not later than May 1, 2014, attempt to negotiate

agreements with property owners to avoid or mitigate potential damages to the structures identified in 3a from flooding, either by elevating the structures or other methods. Such agreements will include identification of funding sources and initial schedule for initiation and completion of avoidance and mitigation work.

SCWA may, alternatively, pursue other actions that will result in the mitigation or avoidance of flood damage to the structures identified in 3a.

d) SCWA shall continue to implement the RPA's adaptive barrier beach management strategy until avoidance or mitigation measures are complete.

e) Not later than October 1, 2014, SCWA will provide quarterly reports to NMFS and CDFG describing progress toward: 1) developing funding mechanisms for avoidance and mitigation activities for flood prone structures in Jenner and 2) negotiating agreements with property owners, or 3) implementing other flood mitigation measures.

Monitoring/Reporting:
In addition to the monitoring and reporting requirements described above:

SCWA shall conduct and record during the year, on a monthly basis, or as determined necessary by NMFS, DFG, SCWA, and the Corps, surveys of the beach topography and outlet channel (including bar elevation). Additionally, SCWA shall place a time lapse video camera at a strategic location to record the interaction of waves, tides and the river mouth. This information will be used to determine the potential for flooding, analyze effects of marine and riverine sediment transport on beach morphology, and to aid in developing estuary and barrier beach adaptive management strategies. SCWA shall provide this information to NMFS, CDFG, and the Corps on a quarterly basis or as requested.

2.2 Monitoring Estuarine Water Quality

Changes in sandbar management are expected to alter water quality in the Russian River estuary by minimizing tidal influence and creating a brackish/freshwater lagoon environment during much of the year. Changing water quality dynamics should enhance the quality of juvenile salmonid rearing habitat in the estuary. Summer water quality in the Russian River estuary was monitored from 1996 to 2000 and from 2005 to 2006 (Merritt Smith 1997, 1998, 1999, and 2000; Sonoma County Water Agency and Merritt Smith Consulting 2001; Martini-Lamb et al. 2006 and 2007 *in preparation*). As part of this RPA, SCWA will 1) continue monitoring salinity, water temperature, dissolved oxygen, and pH during spring, summer, and fall months in the Russian River estuary, and 2) evaluate changes in these parameters as a result of adaptive sandbar management.

Methods:
Water quality monitoring methods are detailed in Martini-Lamb *et al*. (2006 and 2007 *in preparation*). Estuary water quality will be monitored during the spring, summer, and fall using multi-parameter, continuously-recording YSI 6600 water quality meters (sondes).

Sondes will be deployed at multiple stations in the lower, middle, and upper reaches of the estuary as shown on Figure 1 of Martini-Lamb et al. (2007). An additional station will be added in the upper reach between Sheephouse and Freezeout creeks. Stations in the deepest locations will consist of a concrete anchor attached to a steel cable suspended from the surface by a large buoy and an array of sondes. Sondes in the array will be attached to the cable and record water quality conditions at near bottom, mid-depth, and the surface (within 1 meter) of the water column. Some stations that are in more shallow locations may consist of one or two sondes, depending on water depth, that are cabled to the bank. Each station will be located in the deepest part of the channel to capture the fullest water quality vertical profile. The placement of sondes vertically at each station will also track anoxic events and determine if salinity or temperature stratification is present. Calibration will occur every three weeks and data will be downloaded and sondes cleaned during each event.

Sondes will collect hourly water temperature (degrees Celsius), D.O. (milligrams per liter), salinity (parts per thousand), pH, and specific conductance (mho). Monitoring these variables will show how water quality changes with sandbar conditions and how this may affect salmonid habitat in the estuary.

Sampling Frequency and Duration:
Deployment will occur once river flows and turbidity have declined to safe levels (mid-April to early May in most years). Sondes will be retrieved prior to the onset of winter rains (by early November in most years). Water quality will be annually monitored for the first 10 years of this project. Following review of the results of water quality monitoring in the first ten years of the project, the Corps, CDFG, and NMFS will evaluate with input from SCWA the need for additional water quality monitoring during the remaining years of the project. If determined to be necessary because of uncertainty regarding the effectiveness of estuarine water level management in minimizing impacts to listed salmonids, SCWA will conduct additional water quality monitoring.

Reporting and Review:
Water quality data will be summarized in annual reports. These data, along with the summaries, will be forwarded in a report to NMFS and CDFG within nine (9) months of each year's cessation of sampling. SCWA will provide NMFS and CDFG with the collected provisional raw water quality data quarterly or as real time data if the latter is available (*e.g*., estuary water elevation data).

The aforementioned research and monitoring program can be adapted in consultation with NMFS and CDFG pending results of the new sandbar management strategy (RPA 2.1). Adaptation can include changes in sampling frequency, design, and any other changes deemed necessary, including ending sampling prior to 2018 if the purpose and objectives of water quality sampling have been met. Any changes to the water quality sampling program will be forwarded to NMFS and CDFG for review and approval if appropriate.

2.3 Invertebrate Monitoring in the Estuary

Densities of steelhead appear to be low in the Russian River estuary, a condition that is likely due to reduced water quality (*e.g.*, elevated salinity and other water quality dynamics) as well as diminished production of invertebrates that are typically the forage base of juvenile salmonids. Invertebrates are good indicators of ecosystem productivity as their life cycles are closely linked to changes in water and habitat quality (Simenstad *et al*. 1991). Epibenthic invertebrates (primarily crustaceans and insects) are particularly important prey resources for salmon rearing in estuaries (Robinson 1993, Levings 1994). Efforts to enhance production of juvenile steelhead in the Russian River estuary via alterations of summer inflow and water level management practices will likely affect both water quality and invertebrate production in the estuary. It is important that the effects of adaptively managing estuarine water levels on aquatic biota be monitored in order to document improved conditions and avoid any adverse effects. At present, there is a paucity of information concerning invertebrate production in the Russian River estuary.

SCWA will monitor the effects of alternative water level management scenarios and resulting changes in depths and water quality (primarily salinity, dissolved oxygen concentration, temperature, and pH) on the productivity of invertebrates that would likely serve as the principal forage base of juvenile salmonids in the Russian River estuary. Specifically, SCWA will determine the temporal and spatial distribution, composition (species richness and diversity), and relative abundance of potential prey items for juvenile salmonids in the Russian River estuary, and evaluate invertebrate community response to changes in sandbar management strategies, inflow, estuarine water circulation patterns (stratification), and water quality. The monitoring of invertebrate productivity in the estuary will focus primarily on epibenthic and benthic marine and aquatic Arthropods within the classes Crustacea and Insecta, the primary invertebrate taxa that serve as prey for juvenile salmonids. The monitoring effort will involve systematic sampling and analysis of zooplankton, epibenthic, and benthic invertebrate species.

Methods for monitoring invertebrates:
For previous monitoring efforts, the SCWA divided the estuary into three reaches based on water quality (primarily salinity) patterns. The 6-km upper reach extends from Brown's Gulch (11.5 km from the river's mouth) to the confluence of Sheephouse Creek, the middle reach extends 4 km from Sheephouse Creek to the upstream end of Penny Island, and the lower 1.5-km reach extends to the mouth of the Russian River (Martini-Lamb et al. 2006 and 2007). These reaches are used to describe the study stations for the monitoring of invertebrates to be conducted in support of the new approach for managing estuarine water surface elevations.

The composition of invertebrate communities is directly related to habitat conditions within the estuary. Therefore, bathymetric maps that identify vegetated, unvegetated, coarse, fine (sand, silt), and mud substrates in the estuary will be developed prior to sampling. Habitats should be designated according to Cowardin *et al*. (1979) and include vascular plants and benthic algae assemblages. The final invertebrate sampling design will be based on the results of bathymetric maps, water quality sampling information, and estuarine bar condition. SCWA is encouraged to design the invertebrate monitoring program with the assistance of well qualified aquatic invertebrate researchers.

The bathymetry of the Russian River estuary is relatively complex and will likely require several sampling methodologies to adequately evaluate epibenthic and benthic assemblages occurring at various depths. Methods that may be employed include: nets, sleds, Ekman grabs, core borings, suction pump, artificial substrates, and quadrats. Systematic sampling will be conducted at a variety of sites, including three depth ranges along at least one cross-sectional transect in the downstream most reach, and three depth ranges along two transects in each of the upper and middle reaches. Thus, replicate sampling will occur at a minimum of five (5) longitudinal sites spaced approximately evenly along the lowermost 12 kilometers of the river. At a minimum the sampling design will include the spatial and temporal replication described in Table 30.

To further assess changes in invertebrate productivity relative to changes in sandbar condition and water quality, the SCWA will also monitor zooplankton. Zooplankton will be sampled by plankton tow or with a vertical profiling pump (Simenstad *et al*. 1991, Laprise and Dodson 1994) along transects throughout the estuary. Samples will be collected at a variety of sites, including at least one transect in the lower reach and at least two transects in each of the upper and middle

Table 30. Minimum spatial and temporal sampling effort for the annual monitoring of epibenthic and benthic invertebrates in the Russian River estuary during the months of May through October. Replicate samples will be collected at three distances (depth ranges) from shore.

Reach	Lower			Middle						Upper					
Month	M J J A S O			M J J A S O			M J J A S O			M J J A S O			M J J A S O		
Transect	1			2			3			4			5		
Distance from Shore (m)	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45
Depth (m)	0-1	1-3	3+	0-1	1-3	3+	0-1	1-3	3+	0-1	1-3	3+	0-1	1-3	3+
Number Samples	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Total Monthly	9			9			9			9			9		
Total samples May-October	54			54			54			54			54		

reaches (Table 31). Assigning transects throughout the estuary should address the issue of patchy distribution exhibited by zooplankton in response to tidal and freshwater circulation. Zooplankton exhibit daily vertical movements through the water column in response to changes in salinity and light (Day *et al.* 1989; Simenstad *et al*. 1991), therefore samples will be collected at multiple depths at approximately the same time of day. A minimum sampling design should include the spatial and temporal replication shown in Table 31.

The monthly zooplankton monitoring strategy will be augmented once annually by post sandbar closure sampling 7 and 14 days after formation of a stable bar (Table 32). This post-closure sampling strategy will capture the effects of rapid changes in water quality on estuarine biota. The unpredictable nature of sandbar formation and persistence necessitate an adaptive sampling component to fill potential data gaps missed by monthly monitoring.

Water temperature, salinity, and dissolved oxygen levels will be recorded at each transect or sampling location during each sampling event at all depths sampled. A secchi disk will be used to measure turbidity. For zooplankton tows between the bottom and surface, water quality will be sampled near the bottom, mid-depth, and within 1 meter of the surface.

Table 31. Minimum spatial and temporal sampling effort for the annual monitoring of zooplankton in the Russian River estuary during the months of May through October. Tows at a mid channel station from the maximum depth to the surface are replicated three times at each transect.

Reach	Lower	Middle		Upper	
Month	M J J A S O	M J J A S O	M J J A S O	M J J A S O	M J J A S O
Transect	1	2	3	4	5
Distance from Shore (m)	Mid Channel	Mid Channel	Mid Channel	Mid Channel	Mid Channel
Depth (m)	Max to Surface	Max to Surface	Max to Surface	Max to Surface	Max to Surface
Number tows	3	3	3	3	3
Total Monthly	3	3	3	3	3
Total Annual	18	18	18	18	18

Samples will be collected and preserved for laboratory analysis using standard techniques. For each sample collected, organisms will be sorted and identified to the lowest practical taxonomic level, and for the Class Insecta identified to at least the family level using binocular dissecting microscopes as necessary. For each epibenthic and benthic sample, the following data will be determined:

1) Total abundance (number per unit area or volume) of each invertebrate taxa in each sample.
2) Diversity (utilizing the Shannon Weiner index or comparable metric)
3) EPT index
4) combined total abundance of individuals within the Order Amphipoda

For each zooplankton sample, total abundance of each taxa will be determined.

Table 32. A zooplankton sampling strategy for the Russian River estuary to capture changes in productivity 7 and 14 days after a sandbar closure event.

Reach	Lower						Middle												Upper											
Days Post Closure	7			14			7						14						7						14					
Transect No.	1			1			2			2			3			3			4			4			5			5		
Distance from Shore (m)	Mid Channel						Mid Channel						Mid Channel						Mid Channel						Mid Channel					
Depth (m)	Max to Surface						Max to Surface						Max to Surface						Max to Surface						Max to Surface					
Number Tows	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Closure	3			3			3			3			3			3			3			3			3			3		
Total Annual	6						12												12											

The SCWA will also provide a qualitative description of salmonid diet in the estuary. Gastric lavage will be used to evacuate the stomach contents of live steelhead from a variety of size classes (Light *et al*. 1983). Gut contents will be sampled approximately monthly as fish are captured using techniques identified in element 2.4, below. Measures of seasonal diet may include frequency of taxa occurrence and percent composition by number (Bowen 1996).

Bathymetric sampling will be completed prior to 2010 and invertebrates will be sampled from 2010 through 2019. The SCWA will monitor these parameters monthly between May and October (epibenthic and benthic invertebrates and zooplankton) and immediately after lagoon formation (zooplankton) when the sandbar is closed or "perched".

Reporting and Review:
Invertebrate monitoring data will be summarized and evaluated in annual reports. Successful evaluation of invertebrate communities in the estuary is dependent upon methodologies that will be affected by experimental manipulation of the sandbar (*e.g*., changes in water depths and flooded habitats). The aforementioned invertebrate monitoring program can be adapted in consultation with NMFS and CDFG pending results of the adaptive sandbar management strategy. Adaptation can include changes in sampling frequency, design, and any other changes deemed necessary, including ending sampling prior to 2019 if the purpose and objectives of invertebrate sampling have been met. Any changes to the invertebrate sampling program must be approved by NMFS and CDFG. Following review of ten years of results of estuarine invertebrate monitoring for the project, the Corps, CDFG, and NMFS will evaluate, with input from SCWA, the need for additional invertebrate monitoring during the remaining years of the project. If determined to be necessary because of uncertainty regarding the effectiveness of estuarine water level management in minimizing impacts to listed salmonids, SCWA will conduct additional invertebrate monitoring.

2.4 Monitoring of salmonids in the Estuary

As previously stated, changes in sandbar management that create a brackish/freshwater lagoon environment for prolonged periods during summer should enhance juvenile salmonid rearing habitat. A freshwater or perched lagoon environment will have measurably different water quality characteristics (both spatially and temporally) than the estuary under the current management regime. As part of this RPA, SCWA will 1) evaluate seasonal use of the Russian River estuary by juvenile salmonids and 2) study fish response to alternative breaching strategies and resulting changes in water quality.

Methods:
SCWA's Russian Estuary Monitoring Plan, initiated in 2005, has collected information on juvenile salmonid distribution, relative abundance, residence time, and habitat characteristics from early summer to late fall. For this RPA, SCWA will focus and expand these efforts to monitor the response of young-of-the-year steelhead with: 1) monthly beach seining at sites throughout the estuary, 2) fyke net trapping in the upper reach of the estuary, and 3) implantation of passive integrated transponder (PIT) tags.

The primary metric of fish abundance will be mean catch-per-unit-effort (CPUE) defined as the number of juvenile steelhead captured per seine net haul (Hubert and Fabrizio 2007). Net setting techniques recommended in Hahn *et al*. (2007) will be employed at fixed sites in discrete strata sampled repeatedly over time. Annual beach seining surveys will be performed monthly from May to October at 25 sites in each of two (upper and lower) estuary reaches for a total effort of 50 seine hauls per month or 300 total seine hauls per year. An analysis of SCWA's estuary seining data from 2005 to 2007 indicates that this level of sampling intensity is powerful enough to detect a two-fold change in fish abundance (100% difference) between sampling periods (months) and reaches (upper and lower). Should habitat conditions change markedly at the fixed sites over time as a result estuary management, the sampling scheme may need to incorporate adaptively selected sites. Sampling sites (and any changes to the sampling scheme) must be approved by NMFS and CDFG.

Fyke style trap nets in the upper estuary will provide information about the timing of downstream movements of juvenile fish, relative abundance, and the size/age structure of the population (O'Neal 2007). The primary objective of the trap operation is to capture young-of-the-year fish as they enter the estuary. SCWA surveys have identified a likely trapping location 10.5 km above the river mouth in the town of Duncans Mills upstream of the Moscow Road Bridge. SCWA will operate one or two fyke nets with wings. The precise location, number of fyke nets, and type of fyke net will be determined through consultation and with the approval of NMFS and CDFG. The annual period of trap operation is dependent on flow and water stage in the estuary but will generally extend from spring to mid-summer. The efficiency of trap nets will be tested using mark and recapture techniques (Bjorkstedt 2005).

All steelhead greater than 75 mm FL captured in fyke nets or seines will be implanted with PIT tags. Captured fish will be wanded to look for pit tags. The recapture of tagged fish may yield information about estuarine residence time, growth, and survival. Length and weight of all fish will be recording during initial and subsequent recapture. A handheld PIT tag reader must be carried by all field crews. Lengths and weights of fish will be recorded for fish captured at each seining station and fyke net or subsampled as appropriate.

Sampling Frequency and Duration:
Seining surveys will occur monthly from 2009 to 2018 between late spring and fall when river flow, measured at the USGS Hacienda Bridge Gaging Station in Guerneville, is below 300 cfs (typically May to October). Fyke net trapping will occur annually from 2009 to 2018. The initiation of fyke net trapping will also correspond to lower stream flow in spring. The trap net near the head of the estuary in the vicinity of Duncans Mills will be operated from spring (April) until catches decline to near zero (assumed to be in late July).

Reporting and Review:
Data will be summarized in annual reports. These data, along with summaries will be forwarded in a report to NMFS and CDFG within nine (9) months of each year's cessation of sampling. The aforementioned research and monitoring program can be adapted in consultation with NMFS and CDFG pending results of the new sandbar management strategy (RPA 2.1). Following review of the results of fish sampling in the estuary during the first ten years of the project, the Corps, CDFG, and NMFS will evaluate, with input from SCWA, the need for

additional fish sampling in the estuary during the remaining years of the project. If determined to be necessary, SCWA will conduct additional fish sampling in the estuary.

3. Dry Creek Habitat Enhancements

As currently managed, Dry Creek is a critical component of SCWA's Project. The lower 14 miles of the creek conveys flow from the water supply pool in Lake Sonoma to satisfy municipal water demands in Sonoma and Marin counties. Yet, the Dry Creek watershed is also one of the few Russian River tributaries supporting populations of steelhead, coho salmon, and Chinook salmon. DCFH, located at the base of WSD, annually releases about 300,000 yearling steelhead into Dry Creek. The RRCSCBP has released native Russian River origin juvenile coho salmon into one of Dry Creek's tributaries since 2004. Monitoring associated with this Broodstock Program has also detected multiple year-classes of wild (non-program origin) coho salmon in the Mill Creek watershed, a tributary of Dry Creek. Other monitoring has documented extensive use of Dry Creek by spawning Chinook salmon and steelhead. The release of cold hypolimnetic water from Lake Sonoma into Dry Creek provides potentially valuable, abundant rearing habitat for listed salmonid species. However, current (and anticipated future) water releases to Dry Creek in the summer and fall create high water velocities in Dry Creek that severely limit the quantity and quality of salmonid rearing habitat in Dry Creek, regardless of water temperature. Limited rearing habitat hinders the conservation of CCC coho salmon and CCC steelhead, as previously described in this biological opinion. High current velocities, extensive channel incision, and bank erosion limit both the quantity and quality of Dry Creek's winter and summer rearing habitats for juvenile steelhead and coho salmon.

There are probably only three basic approaches to minimizing adverse effects of high summer flow releases on rearing habitat for coho salmon and steelhead: 1) water releases from WSD could be reduced, 2) Dry Creek's channel could be modified to accommodate a higher flow that sustains good quality habitat, or 3) high flow releases could be bypassed around Dry Creek via a pipeline. Immediate substantial reductions in the flows released from WSD during summer would very significantly impact water supply in Sonoma County and Marin County, because Lake Sonoma is the principal municipal water supply for much of Sonoma County and northern Marin County and Dry Creek is an integral part of the county's water transmission system. Therefore, remediation of impacts of high flow releases on salmonid rearing habitat and listed species along 14 miles of Dry Creek would likely require either a major bypass pipeline or substantial alterations in the morphology and structure of the Dry Creek stream channel. Major alterations of the Dry Creek channel would likely need to not only address effects of current levels of flow releases, but also accommodate potential increased flow releases that may result from SCWA's pending application to the SWRCB for additional rights for water held in Lake Sonoma. Channel alterations would require numerous landowner agreements and possibly require acquisition of riparian lands by SCWA. To be implemented, a bypass pipeline would require comprehensive analysis of feasible alternatives, engineering design, considerable efforts for environmental permitting, funding initiatives, and construction. Based on previous analysis by SCWA and NMFS, a major pipeline cannot likely be completed until year 14 or 15 of the 15 year period covered by this biological opinion. For that reason, the bypass pipeline alternative is problematic; under a pipeline option, 14 miles of Dry Creek would remain adversely modified

for an extended time, the entire life of the 15 year project. Therefore, the best approach for addressing the effects of high flow releases at WSD on salmonid rearing habitat is to implement and monitor on-the-ground enhancements of rearing habitat that will avoid adverse modification of critical habitat and appreciably increase the survival of juvenile salmonids in Dry Creek during both summer and winter months.

Although it is reasonably certain that reaches of the Dry Creek channel can be modified to create conditions conducive to the production of steelhead and coho salmon, given the complexity of major habitat enhancements and influences of uncontrollable factors such as major flood events, it will be important to monitor both physical and biological responses to the habitat enhancement structures. In addition, to ensure that adverse modification of critical habitat in Dry Creek is avoided, it would be appropriate to conduct feasibility analysis, conceptual design, preliminary environmental impact assessment, and costing of a Dry Creek bypass pipeline to be implemented if monitoring determined that habitat enhancements to Dry Creek are unsuccessful in generating substantial good quality rearing habitat for coho salmon and steelhead.

This element of the RPA contains two separate actions: 3.1) the enhancement of coho and steelhead rearing habitat along reaches of Dry Creek and its tributaries and 3.2) feasibility and preliminary environmental assessments of a Dry Creek bypass pipeline

3.1 Enhancement of Salmonid Rearing Habitat in the Dry Creek Watershed

The Corps and SCWA will substantially enhance the quantity and quality of rearing habitat for juvenile steelhead and coho salmon in the 14 mile segment of Dry Creek downstream of WSD. To do this, SCWA will enhance low flow season, pool-riffle habitat along the 14 mile segment and install additional large boulder clusters to provide velocity refuges and habitat for juvenile steelhead and coho salmon. The Corps will enhance winter habitat at points along the margins of Dry Creek. As discussed below, these enhancements will be distributed at several locations along Dry Creek and the timing of their installation will be staggered to begin by Year 5 and be completed by Year 12. Because the initial design, permitting, and construction of this work will take up to five years to complete, SCWA will restore or otherwise enhance rearing habitat for salmonids in tributaries that enter Dry Creek downstream of WSD or in other Russian River tributaries supporting coho salmon and steelhead by the end of Year 3 covered by this opinion.

3.1.1 Enhancement of Salmonid Rearing Habitats in Dry Creek

The enhancement of Dry Creek will convert sections of stream containing marginal or poor quality salmonid rearing habitat due to high current velocities and minimal instream cover (*e.g.*, absence of large woody debris) to near optimal quality habitats so that, when WSD releases are 110 to 175 cfs, at least six miles of Dry Creek contains excellent quality habitats for rearing coho salmon and the remaining reaches are enhanced with large boulder clusters, as described by Flosi *et al*. (1998). Flows of 110 to 175 cfs represent the range of high summer flows in Dry Creek during the past decade (USGS gage 11465000) that have been shown to adversely affect summer rearing habitat for coho salmon and steelhead (see Section VI.F). The habitat enhancement project will create both winter and summer rearing habitats for juvenile steelhead and coho salmon, with an emphasis on improving habitats for the survival of juvenile coho salmon.

Enhancement of Summer Rearing Habitat

Depth, velocity and cover preferences of rearing coho salmon during the low flow season are well documented. Beecher *et al.* (2002) state that juvenile coho salmon in western Washington streams in summer showed greatest preference for depths ranging from 0.46 to 1.2 meters, similar to the depths used by introduced coho salmon in New York (Sheppard and Johnson 1985), and juvenile coho in central California (Shapovalov and Taft 1954), experimental stream channels on Vancouver Island (Ruggles 1966), western Washington (Lonzarich and Quinn 1995), and Alaska (Bugert *et al*. 1991). Beecher *et al*. (2002) also provide velocity preference information for juvenile coho salmon:

> *"The greatest preference for velocity in summer in this study was 3-6 cm/s* [0.1-0.2 ft/s], *similar to values found in other studies of juvenile coho salmon (Ruggles 1966; Bovee 1978; Sheppard and Johnson 1985; Bisson et al. 1988; Murphy et al.1989; Dolloff and Reeves 1990; Bugert et al. 1991; Shirvell 1994; Peters 1996). Puckett and Dill (1985) calculated the stationary swimming speed of territorial juvenile coho salmon, based on tailbeat frequency, at just under 10 cm/s. Slow water velocity is related to juvenile coho salmon distribution (Murphy et al. 1989), holding capacity (Ruggles 1966), and habitat use (Bisson et al. 1988; Peters 1996).*

Good quality juvenile coho salmon habitat also contains substantial instream structure such as large woody debris and log jams and low overhanging vegetation that provide cover, velocity refugia, and sources of invertebrate production (Sandercock 1991; Giannico 2000). Juvenile coho also need abundant complex instream structures and sidepool alcoves that provide ample velocity refugia during the high flows of winter (Bustard and Narver 1975; Nichelson *et al.* 1992). Raleigh *et al*. (1984) states that high quality pools for juvenile and adult rainbow trout and steelhead during the late growing season, low flow period have more than 30% of the pool bottom obscured due to depth, surface turbulence, or the presence of structures such as logs, debris piles, boulders, or overhanging banks and vegetation. McMahon (1983) reports that juvenile coho salmon prefer streams with about one-third to two-thirds pool habitat (*i.e.*, McMahon rates streams with 33 to 67 percent pools as having Habitat Suitability Index values of 80% or higher). McMahon (1983) also provides the results of Nicholson and others, who found that during the low flow season in Oregon, good quality pools for coho salmon are 10 to 80 m^3 or 50 to 250 m^2. Conditions providing a combination of depths ranging from 2 to 4 ft, mean column velocities of 0.1 to 0.2 ft/s, ample large woody debris, and sidepool alcoves providing high quality shelter during both low and high flow events also support rearing steelhead (Raleigh *et al*. 1984; Bjornn and Reiser 1991).

The reduction of impacts from high current velocities during the low flow season (June through October) will be accomplished by modifying the Dry Creek channel so that, at flow releases of 110 to 175 cfs, six miles of Dry Creek is contoured to create six miles of high quality riffle and pool habitat for coho salmon with a pool:riffle ratio ranging between 1:2 and 2:1, with all pools providing good quality depth, velocity, cover, and size during the low flow season, using the above described criteria. The riffle: pool habitat enhancements will not be concentrated in a contiguous six miles of stream, but rather will be distributed across eight or more sites including

sites in the upper, middle, and lower portions of Dry Creek. Dry Creek contains a few existing pools (probably with inadequate cover) that may be incorporated into the six miles of riffle:pool enhancements if they can be upgraded to meet the depth, velocity, and cover criteria when flow releases from WSD range from 110 to 175 cfs. In addition, to these channel modifications, a minimum of 20 large boulder clusters will be installed in locations outside of the six miles of stream that are modified to form excellent quality riffle:pool sequences for production of steelhead and coho salmon. As described by Flosi *et al*. (1998), boulder clusters create velocity refuges for resting migrating spawners and rearing habitat for juvenile salmonids. Boulder clusters provide a relatively inexpensive means to create additional velocity refuges for rearing salmonids, especially steelhead that are less dependent on deep pools with abundant cover than juvenile coho salmon (Hartman 1965; Sheppard and Johnson 1985; Bisson *et al*. 1988).

The creation and enhancement of at least six miles of modified channel with high quality pool-riffle sequences with a minimum 1:2 pool-riffle ratio will ensure the creation or enhancement of at least 2.0 miles of high quality pool habitat in Dry Creek. Riffle habitats adjacent to the enhancement zones will also become useable by fishes that periodically leave pools or velocity refuges to forage in higher velocity riffle-run habitats. SCWA will monitor physical habitat conditions and the abundance and microhabitat use of each habitat enhancement site both prior to construction and for at least five years after construction.

SCWA will enhance salmonid rearing habitat in Dry Creek using a five phase approach to construction:

1. two years of conceptual project design and planning;

2. two years for project review, permitting, and pre-monitoring;

3. two years of initial construction of at least one mile of modified stream channel providing excellent quality coho summer rearing habitat with a pool-riffle ratio ranging between 1:2 and 2:1, plus installation of 10 boulder clusters in reaches not otherwise enhanced;

4. two years of construction (years 8 and 9 covered by this opinion) of an additional two miles of modified stream channel providing excellent quality coho summer rearing habitat with a pool-riffle ratio ranging between 1:2 and 2:1, plus the installation of ten additional large boulder clusters in reaches not otherwise enhanced; and

5. two years of construction (years 11 and 12 covered by the opinion) of an additional three miles of modified stream channel providing excellent quality coho summer rearing habitat with a pool-riffle ratio ranging between 1:2 and 2:1.

Table 33. Schedule for the design, construction and monitoring of enhanced salmonid habitats in Dry Creek in response to high seasonal flow releases from WSD.

Year:	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20	'21	'22	'23
Phase:	I		II		III			IV			V		VI		
Engineering Design	Conceptual Design		Permitting & final design: 1st pool:rifflemile		Permitting & final design: 2nd & 3rd pool:riffle mile			Permitting & final design: pool:riffle miles 4-6							
Engineering Construction					Construct 1st mile			Construct miles 2 &3			Construct miles 4,5,6				
Design evaluation & Adaptive Mgmt						Evaluate mile 1 work & boulder clusters			Evaluate miles 2 &3 & boulder clusters			Evaluate enhanced miles 4, 5, and 6			
Monitoring:		Premonitoring			Pre and Post-monitoring						Pre and Post-monitoring				

With support from qualified habitat restoration specialists, SCWA will conceptually design habitat enhancement projects after considering alternative potential sites, availability of potential access, physical constraints, and costs and benefits for alternative designs. The designs will also consider the likely biological potential (quantity and quality of summer and winter rearing habitat) of alternative enhancement designs for individual sites. The project design for the habitat enhancement projects will include geomorphic, hydraulic, biologic, and engineering analyses. Conceptual designs will consider a variety of restoration techniques such as log or rock weirs, deflectors, log jams, constructed alcoves, side channels, backwaters, and dam pools that have successfully increased the quantity and quality of summer and winter rearing habitat for coho and steelhead (Cederholm *et al.* 1997; Solazzi *et al*. 2000; Roni and Quinn 2001; Roni *et al*. 2005).

From this analysis and design, habitat enhancement options will be generated focusing on appropriate life stages and the goal of species recovery. Working with local land owners, DFG, and NMFS, SCWA will prioritize options for implementation.

It is anticipated that the conceptual design of at least eight projects that enhance six miles of Dry Creek with high quality riffle-pool habitats for coho salmon plus approximate locations and design of the additional 10 boulder clusters will be completed in 24 months. Upon completion of the conceptual design of this habitat enhancement work, SCWA will provide copies of the designs and their descriptions to NMFS and DFG for review and approval. During years 3 and 4 of the period covered by this opinion, SCWA will conduct final design, obtain necessary permitting for the project, conduct pre-project monitoring at treatment and control sites, and select a construction contractor. Physical habitat monitoring will include habitat mapping and documentation of depth, velocity, and cover conditions along a series of cross-sectional transects within each habitat enhancement site. Biological monitoring techniques could include downstream migrant trapping, PIT tagging to evaluate movement, snorkel surveys and

electrofishing. A plan for physical and biological monitoring protocol will be prepared and submitted to NMFS and CDFG for review and approval. The first mile of habitat enhancement work and ten additional boulder clusters will be constructed by the end of Year 6. During construction, if project implementation requires the dewatering of aquatic habitat, SCWA will relocate any fish, including listed salmonids, from areas to be dewatered. Relocated fish will be placed in appropriate aquatic habitat upstream or downstream of enhancement sites. Following construction of Phase III enhancement sites (one mile), SCWA will conduct post-construction monitoring at Phase III treatment and control sites for five consecutive years. Post-construction monitoring will evaluate project implementation (construction), effectiveness (physical habitat response), and validation (biological response) as described below.

In Phase III, SCWA will also design and permit enhancement projects (modification of habitat in another 2 miles of stream) that will be constructed during Phase IV (Years 8 and 9 covered by the opinion). Projects to be constructed during Phase V (Years 11 and 12 covered by the opinion) will be designed and permitted during Phase IV. Upon completion of the conceptual design of habitat enhancement work to be done in Phases IV and V, SCWA will provide copies of the designs and their descriptions to NMFS and DFG for review and approval for construction. As described for Phase III construction, if construction during Phase IV and V requires the dewatering of aquatic habitat, SCWA will relocate any fish, including listed salmonids, from areas to be dewatered. Relocated fish will be placed in appropriate aquatic habitat upstream or downstream of enhancement sites.

Prior to construction of Phase III, IV, and V enhancement projects, SCWA will develop and submit to NMFS and CDFG for review and approval, a post-construction adaptive management, monitoring, and evaluation plan that will identify project goals, objectives, and success criteria.

The goal of the plan will be to monitor the populations and the habitat they live in (*i.e.*, coho salmon and steelhead in Dry Creek and the enhanced tributaries associated with the RPA) over multiple years (pre- and post-restoration and enhancement) to detect change from the treatment conditions and distinguish between background noise or non-treatment variables. Pre-project monitoring would collect multiple years of data before habitat restoration and enhancement efforts are applied at treatment sites in Dry Creek, and post-restoration/enhancement monitoring would encompass the adjustment phase of the stream habitat and fish populations to the work and subsequent changes to the conditions of the habitat and population. Reference control sites will be identified and monitored such that background noise and confounding variables can be evaluated and treatment reaches compared to the new conditions of the stream and habitat.

Objectives should be clearly identified (*e.g.*, improve habitat conditions, lengthen freshwater residency, increased over-summer/winter survival, increased macroinvertebrate productivity, with measurable attributes (*e.g.*, increased depth,/cover)).

Success criteria should be based on expected physical and biological responses of each objective (*e.g.*, improved rearing habitat, longer residency, successful rearing, successful spawning, *etc.*). Success criteria will also identify post-project treatment measures which will be initiated if the expected target criteria are not met.

Following construction of Phase III, IV and V enhancement projects, SCWA will implement a NMFS and CDFG approved post-construction adaptive management, monitoring and evaluation plan. SCWA will conduct for five consecutive years post-construction monitoring that will measure the projects ability to meet satisfactory physical and biological response criteria at each treatment and control site. Following the protocols of CDFG (2003) and Duffy (2005) and in consultation with NMFS and DFG, that post-construction monitoring will include:

1. implementation monitoring to determine if the habitat enhancement/restoration was done according to the approved design,
2. effectiveness monitoring to determine if the restoration is having the intended effect on physical habitat quality, and
3. validation monitoring to assess whether the habitat enhancement/restoration work is achieving the intended objective (i.e., creating habitat that is inhabited by listed salmonids and appreciably improves the production and survival of rearing steelhead and coho salmon in Dry Creek).

Based on the results of annual post-construction monitoring, SCWA, at the discretion of NMFS and CDFG, will re-visit engineering techniques and approaches for addressing minimization of effects of high flow releases from WSD on rearing salmonids. If deemed necessary by NMFS and CDFG, SCWA, at the direction of NMFS and CDFG, will appropriately modify the habitat enhancement sites or implement alternative enhancement projects. The monitoring in the year following Phase IV construction (*i.e.*, during Year 10) will be a key milestone for evaluating the efficacy of the habitat enhancement program for Dry Creek. In Year 10, SCWA, in consultation with NMFS and DFG, will evaluate the success of the habitat enhancements conducted in Phase III and IV prior to undertaking major efforts scheduled for Phase V.

Enhancement of Winter Rearing Habitat

Juvenile steelhead and coho salmon utilize markedly different habitats during winter and summer (Bustard and Narver 1975; Quinn 2005). During the high flows of winter, coho salmon typically seek off-channel habitats in low velocity areas with substantial cover (Tschaplinski and Hartman 1983). Quinn (2005) states that during winter, salmon (particularly coho salmon) move from inhospitable main channel areas to flooded wetlands, beaver ponds, tributaries, and a variety of off-channel habitats. Bell (2001) documented increased fidelity and survival of winter rearing juvenile coho salmon in alcoves and backwaters in a Northern California stream. Others have documented increased densities of coho salmon in side-channel pools (Bjornn and Reiser 1991).

The 14 mile segment of Dry Creek below WSD lacks natural sinuosity, backwaters, and natural floodplains as the result of stream channelization processes. These conditions have appreciably reduced the availability of potential winter rearing habitat for coho salmon. Ongoing channel maintenance in Dry Creek helps to maintain these conditions. As a result, over-wintering coho are likely displaced by high flows associated with flood control releases.

To address this problem, the Corps will assist SCWA in the design of the eight summer habitat enhancement sites described above, so that each of these sites will include winter habitat for coho salmon. The design for salmonid winter habitat enhancements will be integrated with the summer habitat enhancement projects to be reviewed by NMFS and DFG. The Corps will be

responsible for implementing channel modifications that insure the presence of low velocity refugia with instream cover adequate to protect coho salmon during flow releases of 2500 to 6000 cfs. To promote the longevity of the enhanced winter habitats, banks will be stabilized using bioengineered approaches.

3.1.2 Enhancement of Salmonid Rearing Habitats in Tributaries to Dry Creek and the Russian River

Because of the endangered status of coho salmon and because enhancements of Dry Creek habitats will likely not be constructed until five years after completion of the biological opinion, it is important that SCWA take actions to promote the survival and recovery of coho salmon in the Dry Creek watershed prior to year 5 of the project. NMFS, DFG, and SCWA have identified several projects that would benefit the survival of coho salmon in tributaries of Dry Creek and the Russian River that have significant potential coho salmon rearing habitat. These projects include:

1. Crane Creek Fish Passage Access Project

NMFS (2007) found that the extreme lower portion of Reach 1 on Crane Creek is severely incised due to previous gravel mining and channelization activities in Dry Creek. The most severe evidence of down-cutting is in the downstream-most 100 yards of the stream up to the point of a head-cut that presents a partial or complete barrier to salmonids depending on flows, species, and life stage. SCWA will improve fish passage conditions for multiple species and life stages of salmonids with the lower section of Crane Creek. Structure type and anchoring technique, if needed, will be identified and must be reviewed at higher flows. The design for this work must be reviewed for approval by NMFS and the DFG Fish Habitat Specialist. There are 2 landowners within this reach, and they both granted NMFS access in 2007. This reach is a complete upstream migration barrier for juvenile coho salmon and steelhead, and it is partial migratory barrier for adult salmonids. Removal of this barrier would improve passage conditions for adult coho salmon and steelhead by a 25% improvement factor[75] (B. Coey, DFG, personal communication) and restore access to approximately 4021 m^2 spawning and rearing habitat. Estimated cost for this work is $10,000.

2. Crane Creek In-stream Habitat Improvement Project

NMFS (2007) found pool frequency is high within Crane Creek and includes a moderate to high number of pools with adequate depth; however, pool shelter is low in reaches 1 and 2. Some areas within this reach are incised and highly erosive and would benefit greatly from additional bio-engineering bank stabilization techniques, increased riparian setbacks, streambed toe stabilization, large woody debris (LWD)/ boulder structures and native re-vegetation. A typical project to restore in-stream habitat conditions within Crane Creek may include the installation of LWD and boulder structures (*e.g.*, plunge weirs, boulder and log weirs, digger logs, cover structures, *etc.*) on a ***reach level***. Installation of at least 25 complex LWD and boulder structures within a 4000 ft section of Crane Creek would enhance approximately 645 m^2 of tributary rearing habitat for coho salmon and steelhead. DFG estimates that this project would require a 50% improvement factor for the enhanced stream

[75] The amount of time that adult salmonids would be able to successfully pass upstream would be increased by 25%.

habitat, *i.e*., increase the numbers of salmonids in restored reaches by 50% (B.Coey, DFG, personal communication). Additional habitat improvement projects including bio-engineered bank stabilization techniques, increased riparian setbacks, streambed toe stabilization, and native revegetation may substitute the LWD project mentioned above, but must contain an equal improvement value of 50%. Structure type, anchoring techniques, and habitat improvement factors will need to be identified and then reviewed for approval by NMFS and the DFG Fish Habitat Specialist. The section that contains the lowest shelter values begins 4300 ft from the confluence of Dry Creek and extends upstream for an additional 4000 ft. There are three landowners within this segment, and they all granted NMFS access to assess stream habitat conditions in 2007. The estimated Cost for this work is about $75,000 to $100,000.

3. Grape Creek Fish Passage Enhancement Project

NMFS (2007) identified artificial structures that are passage barriers for one or more life stages of anadromous salmonids within the Grape Creek Watershed. Taylor *et al*. (2003) prioritized 78 stream crossings that should be addressed to improve fish passage in the Sonoma County portion of the Russian River Basin. The West Dry Creek Road crossing was ranked 14 as a high priority for removal. Some of the grade control structures installed to address fish passage at this crossing may also impede fish passage at moderately low flows. Coho salmon already are able to pass through this culvert at certain flow levels; however, changes in the hydraulics within the culvert could extend the amount of time that the culvert is passable, increase the likelihood that coho would successfully migrate past this road crossing, and potentially increase the number of adult coho salmon and steelhead that might spawn in this stream. To successfully implement this project, SCWA will utilize designs currently being developed under contract with DFG to implement fish passage improvements via complete removal (natural channel bottom) or retro-fit (*i.e*., curbing and baffles) within the existing county culvert. The grade control structure immediately downstream of the culvert will be adjusted to match the new channels modified elevation to allow fish passage for all life stages of salmonids. Designs shall meet DFG/NOAA criteria and be approved by NMFS and DFG prior to construction. Implementation of significant enhancements of fish passage opportunity at the existing county culvert and the grade control structures immediately downstream of this culvert would increase opportunities for coho salmon to access approximately 1977 m^2 of spawning and rearing habitat. DFG estimates that this project would approximately double the opportunity for migrating adult salmon and steelhead to ascend Grape Creek (B.Coey, DFG, personal communication). Estimated cost would be dependent on the method used to enhance passage opportunity and range from about $50,000 to about $300,000. Provision of an arched culvert with a natural channel bottom would likely provide the greatest improvement in passage opportunity for this important salmonid stream and would be the more expensive alternative.

4. Grape Creek In-stream Habitat Improvement Project

NMFS (2007) found low pool shelter ratings throughout all reaches in Grape Creek and recommended the installation of cover structures in existing pools to promote recovery of coho salmon and steelhead. The quality and quantity of spawning and rearing habitat in this stream can be increased through the implementation of habitat improvement projects including bio-engineered bank stabilization techniques, increased riparian setbacks,

streambed toe stabilization, log and boulder structures (*e.g.*, plunge weirs, boulder and log weirs, digger logs, cover structures) and native re-vegetation on a ***reach level***. SCWA will enhance spawning and rearing habitat conditions by a 50% improvement factor in 730 m^2 of Grape Creek (this will likely require enhancements in roughly 2000 linear feet of stream) Structure type, anchoring techniques and habitat improvement factors specific to each site will need to be identified, reviewed and approved by NMFS and the DFG Fish Habitat Specialist. The section that contains the lowest shelter values begins 5600 ft from the confluence of Dry Creek and extends upstream for 1000 ft; the second section for this project begins 9800 ft from the confluence of Dry Creek and extends upstream for 1000 ft. There are three landowners bordering the lower section and three landowners bordering the upper section. Estimated cost for this effort is $75,000 to $100,000.

5. Wine Creek In-stream Habitat Improvement Project

NMFS (2007) assessed habitat conditions on Wine Creek, a tributary of Grape Creek, and found low pool shelter ratings and low pool to riffle ratios in the lowermost five reaches. In the fall of 2007, twelve log and boulder weir structures were installed to provide velocity refuge, cover, and deeper pools for spawning salmonids, and to trap and sort suitable spawning gravels throughout the first portion Reach 1. Further improvements of the riparian zone in Reach 1 could address bank erosion, reduce sediment inputs, lower stream temperatures, buffer urban and agricultural runoff, and complete habitat improvements in Reach 1. Additional work is also needed in the upstream reaches to alleviate the low shelter ratings and low pool to riffle ratios.

To improve the quality of salmonid habitats in Wine Creek, SCWA will improve the riparian zone in Reach 1 by utilizing bio-technical approaches to treat bank erosion and enhance low canopy areas by planting and (maintaining newly planted) native, overstory tree species. In addition, SCWA will restore upstream reaches through the installation of 12 LWD and boulder structures (*i.e.*, plunge weirs, boulder and log weirs, digger logs, cover structures). Those installed instream structures will be placed in Wine Creek along the 2500 ft long segment immediately upstream from a point 2900 ft above the confluence with Grape Creek (*i.e.*, DFG reaches 2, 3, and 4). Structure type and anchoring technique for each structure will need to be identified and then reviewed and approved by NMFS and the DFG Fish Habitat Specialist. There are 6 landowners within this section, and they all granted access to NMFS in 2007. We estimate that this project will enhance carrying capacity by about 25% in about 390 m^2 of habitat (B.Coey, DFG, personal communication) in Wine Creek and cost approximately $50,000 to $75,000.

6. Wallace Creek Fish Passage Enhancement Project-

NMFS identified artificial structures that are passage barriers for one or more life stages of anadromous salmonids within the Wallace Creek Watershed. Taylor *et al.* (2003) prioritized 78 stream crossings that should be addressed to improve fish passage in the Sonoma County portion of the Russian River Basin. The Wallace Creek Rd/Mill Creek Rd crossing was ranked as a high priority for removal. Adult salmonids are likely already able to pass through this culvert at certain flow levels; however, changes in the hydraulics within the culvert could extend the amount of time that the culvert is passable, increase the likelihood that coho would successfully migrate past this road crossing, and potentially increase the

number of adults that might spawn in this stream. Remediation would enhance passage opportunity for adult coho salmon and steelhead by a 50% improvement factor, thereby likely increasing the potential production of these species in about 5990 m^2 of stream (B.Coey, DFG, personal communication). SCWA will utilize designs currently being developed under contract with DFG to implement fish passage improvement via complete removal (natural channel bottom) or retro-fit (*i.e.*, curbing and baffles) within the existing county culvert . Designs shall meet DFG/NOAA criteria and be approved by DFG Fish Passage Engineers prior to construction. Estimated cost would be dependent on the method used to enhance passage opportunity and range from about $75,000 to about $300,000. Provision of an arched culvert with a natural channel bottom would likely provide the greatest improvement in passage opportunity for this important salmonid stream and would be the more expensive alternative.

7. Purrington Creek Fish Passage Enhancement Project

The DFG has identified artificial structures that are passage barriers for one or more life stages of anadromous salmonids within the Purrington Creek watershed. One of the Sonoma County road crossing culverts on Purrington Creek has been identified as a partial barrier to adult and juvenile coho salmon and steelhead. SCWA will utilize designs currently being developed under contract with DFG to implement fish passage improvement via complete removal (*i.e.*, natural channel bottom) or retro-fit (e.g. curbing, baffles) within the existing county culvert. Designs shall meet DFG/NOAA criteria and be approved by DFG Fish Passage Engineers prior to construction. Remediation would enhance passage opportunity for adult coho salmon and steelhead by a 50% improvement factor, thereby likely increasing the potential production of these species in about 2650 m^2 of stream (B.Coey, DFG, personal communication). Estimated cost would be dependent on the method used to enhance passage opportunity and range from about $75,000 to about $300,000. Provision of an arched culvert with a natural channel bottom would likely provide the greatest improvement in passage opportunity for this important salmonid stream and would be the more expensive alternative.

8. Willow Creek Fish Passage Enhancement Project

Willow Creek is a tributary to the lower Russian River that once supported an abundant sub-population of coho salmon. The creek continues to support significant potential spawning rearing habitat; however, access to that habitat is blocked by impassable road culverts and a shallow braided channel that passes through forested wetland. DFG has identified artificial structures that are passage barriers for one or more life stages of anadromous salmonids within the Willow Creek Watershed. A Sonoma County road crossing culvert has been identified as a complete barrier to salmonids and a partial barrier to bedload associated with impacted watershed conditions. DFG has funded road improvement projects on private and public roads to reduce non-point source sediment and non-profit entities have implemented improvements to point-source sediment sources. The California State Parks and Stewards of the Coast and Redwoods, a non-governmental environmental organization, have funded the engineering design and completion of the CEQA document for the improvement of fish passage opportunity at the "2nd Bridge" on Willow Creek. The 80% engineering design is scheduled for completion by May 2008; CEQA documentation is scheduled for completion by September 2008. The project will likely be able to be constructed during 2008; however, the remaining engineering design and project construction will need funding. SCWA will

support this fish passage enhancement project by State Parks by funding $100,000 of the construction costs. This project will help restore adult coho salmon and steelhead access to 9480 m^2 of spawning and rearing habitat for these species. The passage project will improve passage for adult salmonids by a 50% improvement factor (B.Coey, DFG, personal communication).

9. Mill Creek Fish Passage Improvement

In Mill Creek, tributary to Dry Creek, a significant barrier (a recently undermined flashboard dam on private property) exists midway in the watershed which is a partial barrier to migration for adult and juvenile coho and steelhead. SCWA will seek landowner permission to design and implement a step pool fishway through the crossing footprint which stabilizes the stream channel, and provides passage to pristine upstream habitat. Remediation would enhance passage opportunity for adult coho salmon and steelhead by a 50% improvement factor, thereby likely increasing the potential production of these species in about 23,760 m^2 of stream (B.Coey, DFG, personal communication). The estimated cost of this highly important project is $100,000 to $200,000.

10. Redwood Creek Fish Passage Improvement Design-

Redwood Creek, tributary to Maacama Creek, is a documented coho stream in the Knights Valley area of the Russian River watershed. A significant barrier (a recently undermined Arizona concrete crossing) exists midway in the watershed which is a complete barrier to migration for adult and juvenile coho and steelhead. SCWA will design and implement a step pool fishway through the crossing footprint which stabilizes the stream channel, and provides passage to pristine upstream habitat. Remediation would enhance passage opportunity for adult coho salmon and steelhead by a 50% improvement factor, thereby increasing the potential production of these species in about 3950 m^2 of stream (B.Coey, DFG, personal communication). The estimated cost of this project is $200,000 to $300,000.

If project implementation requires the dewatering of aquatic habitat, SCWA will relocate any fish, including listed salmonids, from areas to be dewatered. Relocated fish will be placed in appropriate aquatic habitat upstream or downstream of enhancement sites. Implementation of some of these projects would involve enhancement of stream habitat on private lands, others involve activities on public lands (*e.g.*, public road crossings). SCWA will attempt to gain access and permission to complete the above projects on private lands; however, at a minimum SCWA will implement at least five of the above projects on Dry Creek tributaries by end of year 3 of the 15 year period covered by this biological opinion. Any combination of five (5) stream habitat enhancement projects and/or fish passage improvement projects will provide habitat or access to habitat with resulting increases in the survival of juvenile steelhead and coho salmon until those individuals reach the downstream migratory (smolt) stage.

Prior to constructing the five or more habitat enhancement projects or fish passage improvement projects in Russian River tributaries, SCWA will develop and submit to NMFS and CDFG for review and approval, a post-construction adaptive management, monitoring, and evaluation plan for these projects. The monitoring and evaluation plans for these projects will identify goals, and objectives, and success criteria using protocol similar to that described above for the Dry Creek habitat enhancements. Similar to the post-construction monitoring for Dry Creek habitat

enhancements, tributary restoration project monitoring will include implementation monitoring, effectiveness monitoring, and validation monitoring. SCWA will implement the habitat restoration projects in the tributaries of Dry Creek and the Russian River after their project design plans and monitoring plans are reviewed and approved by NMFS and CDFG. NMFS and CDFG will be consulted throughout the planning and implementation process and a written report will accompany the completion of each project phase for the habitat restoration projects within the Dry Creek and Russian River tributaries.

3.2 Dry Creek Bypass Pipeline Feasibility Study

SCWA will investigate the feasibility of constructing a pipeline to deliver water from Lake Sonoma to the mainstem of the Russian River in order to reduce the adverse effects of relatively high flow releases from WSD on rearing habitat for coho salmon and steelhead. A pipeline from Lake Sonoma to the Russian River would eliminate the need to maintain flows in Dry Creek at levels that preclude abundant juvenile salmonid rearing in 14 miles of this stream. As part of this assessment, SCWA will examine the routing options and associated infrastructure needs for construction and operation of a pipeline from Warm Springs Dam to the Russian River outside of the Dry Creek watershed. The objective of this task is an alternatives analysis for two or three possible routes and their associated costs. An assessment of bypass pipeline alternatives will enable SCWA to identify the best method to ensure water deliveries while meeting salmonid habitat needs in Dry Creek in the unlikely event that habitat enhancement efforts described in 3.1 above are unsuccessful in supporting successful growth and survival of juvenile steelhead and coho salmon and protecting the function and role of critical habitat. The assessment of a Dry Creek bypass pipeline will also consider potential impacts to listed salmonids that may occur during construction of such a project.

In its assessment of alternative Dry Creek bypass pipelines, SCWA will employ standard engineering and economic assessment practices. The study will include conceptual design and costing of alternative raw water pipelines, appurtenances, and inlet/outlet structures, including a new inlet structure at Lake Sonoma. The pipeline would be designed to enable SCWA to bypass its water supply releases past Dry Creek, with the exception of an approximately 35 to 50 cfs flow that would be released from WSD directly to Dry Creek. Study of potential hydroelectric generation facilities may be included. The study will also include analyses of the effects of elevated flow levels on listed salmonids and their habitats in the Russian River in the vicinity of potential outlet structures and downstream of the anticipated discharge locations.

SCWA will initiate the Dry Creek bypass pipeline study during fall 2008 and complete the study no later than December 2010. SCWA will transmit the results of the completed report for this study to NMFS.

As part of the environmental review process (*i.e.*, CEQA documentation) for the permanent changes to D1610, SCWA will provide a preliminary environmental analysis of alternative Dry Creek bypass pipeline routes. That analysis shall describe, at a minimum, the potential geological, hydrologic, botanical, fish, and wildlife effects of alternative pipeline scenarios that might occur as the result of changes in Dry Creek minimum flow requirements.

4. Coho Broodstock Program Enhancements

4.1 Coho Broodstock Program Monitoring and Genetic Analysis

Initiated in 2001, the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) was established to: 1) prevent extirpation of Russian River coho salmon; 2) preserve genetic, ecological, and behavioral attributes of Russian River coho salmon while minimizing potential effects to other stocks and species; and 3) build a naturally-sustaining coho salmon population (Corps and SCWA 2004). Annual spawning of the captive broodstock is currently conducted by adhering to a genetic spawning matrix to maximize genetic diversity of the coho salmon produced, and to minimize adverse effects to the genetic composition of the Russian River coho salmon. The RRCSCBP includes a monitoring and evaluation component that provides information on juvenile coho salmon release strategies, over-summer survival, over-winter survival, and adult coho salmon returns. The Corps and SCWA (2004) state,

> *"The proposed project for coho salmon is a continuation of the coho salmon captive broodstock integrated recovery program to be extended as necessary beyond the current expiration of 2007."*
>
> *"State-of-the-art genetic analyses will be conducted for all fish used in the program, and the results of the analysis will be used to dictate the combinations of mature coho salmon to use in the spawning process."*
>
> *"Monitoring and evaluation of critical areas will be conducted to ensure that the coho salmon integrated recovery program is operating in a successful manner."*

However, the continuation of the genetic management, and the monitoring and evaluation components are uncertain due to the lack of committed long-term funding. These components of the RRCSCBP ensure the program is accomplishing the goal of preventing coho salmon extirpation in the Russian River. Without monitoring and evaluation, the success of the program will be difficult to judge and the program cannot be adjusted accurately if program efforts are not as successful as anticipated. Without use of a genetic spawning matrix, inbreeding may further threaten the fitness of fish released by the program.

Given the central importance of the RRCSCBP 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 for these activities, with adjustments for inflation. Recent NOAA and DFG funding for these activities has been approximately $250,000 for annual monitoring and evaluation and $50,000 for annual genetics analysis of the coho broodstock program.
With this effort, the Corps will ensure that:

1. state-of-the-art genetic analyses 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.

2. 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.

3. Monitoring and evaluation of the RRCSCBP 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.

4. The RRCSCBP will be adaptively managed based on information gathered from the monitoring and evaluation component.

Annual genetic and spawning information, and information from each year's monitoring and evaluation component will be included in the annual report submitted for the section 10 permit that authorizes the RRCSCBP.

4.*2 Warm Springs Dam Emergency Water Supply Line*

The Emergency Water Supply Line (EWSL) was constructed at the WSD to provide bypass flow to the DCFH and to Dry Creek during annual or periodic inspections. The current EWSL at Warm Springs Dam has proven unreliable in providing the necessary bypass flows, since its construction in 1992, and it has not been able to provide an emergency water supply flow to the fish facility or Dry Creek when needed. The fish hatchery is crucial to the RRCSCBP, and an EWSL is necessary to prevent the catastrophic loss of three brood years of coho salmon broodstock held each year at the hatchery. The hatchery requires flows of 35 to 50 cfs for its current operations, and modifications to the hatchery would require additional water (up to 75 cfs total), which is not available through the existing pipeline and backup supply.

As part of the RPA for this project, the Corps will construct a new EWSL to ensure that water flow to the DCFH does not fail. A new EWSL would also have the potential to provide bypass flows to Dry Creek during pre-flood and periodic inspections and during-repairs. The system must be designed to provide a minimum of between 60 cfs and 75 cfs, to the fish hatchery that can also be used as a bypass flow to Dry Creek during inspections and repairs to the outlet works.

The Corps will complete a feasibility level report before initiating construction of a flow bypass system at Warm Springs Dam by 2010. The flow bypass system will be completed by 2012. The Corps will provide NMFS with at least annual updates on the progress, plans, and funding of the new EWSL until implementation.

4.3 Coho salmon broodstock smolt program

The RRCSBSP involves the stocking of juvenile age 0+ coho salmon into coho salmon rearing habitat in several Russian River tributaries. In its infancy, the program has, to date, successfully reared and planted two year classes of juvenile coho that have reached an age sufficient to yield returning adult spawners. However, the numbers of stocked juveniles have been relatively low in the early years of this program, and adult returns appear to be very low (less than 5

documented adult coho salmon per year, M. Obedzinski, U.C.Davis Extension, personal communication).

In order to avoid reducing the likelihood of both survival and recovery of Russian River stock coho salmon until adverse effects of high summer and fall flow releases from WSD are remedied in Year 12 of the period covered by this opinion (see RPA element 3.1 above), the Corps and SCWA will expand the RRCSBSP to include a smolt stocking program that would complement the planting of wild-stock, juvenile coho salmon. Funding for this effort will be provided to DFG to facilitate the rearing of smolt stage coho salmon beginning one year after issuance of this final biological opinion. The annual production of 10,000 smolt stage coho salmon at the WSD hatchery and their release in Dry Creek at WSD would likely yield the annual return of approximately 100 adult Russian River stock coho salmon to the WSD hatchery (assuming a 1% marine survival) for spawning and production of a succeeding generation. This will help ensure that enough adult coho salmon are available to continue the captive broodstock program. The RRCSBSP is managed by the DFG under contract to the Corps. Expansion of that program to include smolt rearing will require one additional seasonal technician, additional fish feed and supplies, additional rearing facilities, and additional genetic analysis of returning adult coho salmon. The genetic analysis of returning adult coho salmon is needed to avoid inbreeding of siblings and ensure the genetic integrity and diversity of Russian River stock coho salmon. The genetic analysis will be performed annually prior to the spawning of the adult coho that return to the WSD Hatchery.

Following review of the results of post-construction monitoring outlined in section 3.1.1 and 3.1.2 of this RPA in the first twelve years of the project, the Corps, CDFG, and NMFS will evaluate, with input from SCWA, the need for additional funding of the coho broodstock smolt program during the remaining years of this project (Years 13-15). If determined to be necessary because of uncertainty regarding SCWA's ability to attain satisfactory success criteria described in section 3.1.1 and 3.1.2. of the RPA, SCWA will fund the coho broodstock program throughout the term of the project covered by opinion.

5. Annual Monitoring of Salmonid Migration in the Russian River at Mirabel/Wohler and Dry Creek

The inflatable rubber dam at Mirabel, is a critical component of SCWA's water supply infrastructure during the low-flow season (April to November). Previous upstream and downstream fish passage monitoring at Mirabel/Wholer have revealed previously unknown population trends including annual abundance of both juvenile and adult migrants and migration timings (Chase et al. 2007). Continuation of the program will provide important support for the efforts to recover steelhead, Chinook salmon, and coho salmon in north-central California. Gauging the success of these efforts through life cycle monitoring will allow adaptive management of future restoration projects.

As part of this RPA, SCWA will 1) monitor juvenile outmigration using rotary screw traps at the Mirabel Dam site, 2) monitor adult escapement using underwater video at Mirabel Dam fish ladders, 3) monitor juvenile outmigration using a rotary screw trap in the lower reach of Dry Creek, and 4) monitor juvenile coho and steelhead abundance at multiple sites in Dry Creek.

Methods:
The primary objectives of rotary screw trapping at Mirabel are: 1) young-of-the-year Chinook salmon population estimates, 2) total counts and timing of juvenile steelhead and coho salmon, 3) characterization of size and age of captures, and 4) PIT tagging of juvenile steelhead for subsequent monitoring. Two rotary screwtraps (1.4-m- and 2.5-m-diameter) will be operated annually 50 m below the Mirabel Dam site during spring (April to July). When river flow allows, the traps will operate 24 hours per day, 7 days per week, and will be checked once daily. Up to 50 age 0+ Chinook salmon greater than 60 mm FL will be marked daily and released upstream of the trap site to determine catch efficiency for population estimates. All other fish will be released immediately downstream. A subsample of captured Chinook salmon, coho salmon, and steelhead will be weighed and measured. All coho salmon will be checked for marks and tags applied by the Captive Broodstock Program. All wild steelhead greater then 75 mm FL will be PIT tagged. Trapping methods are described further in Chase *et al*. (2005).

The primary objective of adult escapement monitoring is to provide annual counts of Chinook salmon passing through ladders at Mirabel Dam. The Dam is operated during the majority of the Chinook salmon immigration period. Some overlap with early returning steelhead and coho salmon is also possible. Video counts are not population estimates and should only be considered escapement minimums. Denil-style fish ladders on both sides of Mirabel Dam are equipped with underwater digital cameras that continuously record passing fish. The system only operates when the Dam is inflated. Time lapse images are stored electronically and reviewed immediately by trained technicians who identify species and record time of passage. Video counting methods are described further in Chase *et al*. (2005).

Despite its potential significance for coho salmon and steelhead recovery in the Russian River watershed, little is known about juvenile salmonid abundance in the mainstem of Dry Creek. Annually, SCWA will operate a 1.5-m- diameter rotary screwtrap in lower Dry Creek near the city of Healdsburg in the vicinity of the West Side Road Bridge. Trapping will commence in spring (April) and continue through summer (September). General methods will follow trapping procedures previously described for the Mirabel Dam site with the following additions and exceptions: 1) mark and recapture population estimates will be generated for juvenile coho salmon and wild steelhead, 2) continuous operation of the trap may be suspended during times when Don Clausen Fish Hatchery releases large numbers of yearling steelhead, and 3) the period of trap operation may vary pending the results of an initial two year pilot study (2009-2010).

During the initial pilot study period, SCWA will augment the screw trapping station with small trapnets or other field sampling efforts designed to capture fry at multiple sites in mainstem Dry Creek. Fry trapping will be conducted during spring and will primarily: 1) identify stream reaches utilized by spawning coho salmon and steelhead and 2) investigate timing and patterns of fish movement among reaches.

To further investigate abundance and habitat use in Dry Creek SCWA will implement an annual juvenile steelhead and coho salmon rearing survey. The primary objective of the survey is an index of juvenile abundance at multiple sites during late summer. High summer discharge from WSD creates depth, turbidity, and water velocity conditions in Dry Creek that are not conducive

to standard juvenile sampling methods such as snorkeling and electrofishing. However, annual maintenance inspections at Warm Springs Dam require greatly reduced flow releases and present an opportunity to collect juvenile abundance data using standard techniques. Inspections typically occur in late September. During the inspection period, SCWA relinquishes control of dam releases to USACE for up to 4 days. Typical flow rates in Dry Creek during this period range from 25 to 50 cfs. During the inspection period SCWA and USACE will slowly ramp down flow on day 1, maintain a consistent discharge of 25-50 cfs on days 2 and 3, and slowly ramp flows up to normal discharge on day 4. On days 2 and 3 of the inspection period, SCWA will implement a juvenile abundance survey at multiple sites along 22 km of mainstem Dry Creek from the Russian River confluence upstream to Warm Springs Dam. The number, location, and length of sampling reaches may be constrained by property ownership, field crew access, or habitat characteristics. Specific sampling protocols using snorkeling and electrofishing must be tested to ensure abundance data provide an index that allows spatial (site to site) and temporal (year to year) comparisons. Possible sampling schemes could include depletion-removal electrofishing, mark-recapture electrofishing, single pass electrofishing, multiple pass snorkel counts, or a two-phase approach using snorkel counts validated by habitat specific population estimates derived from electrofishing. During a two-year pilot study (2009-2010), SCWA will evaluate these sampling approaches at eight separate 100 m-long reaches spaced approximately 3 km apart along the 22 km-long mainstem length of Dry Creek. This intensive effort will require a field crew of 15 individuals and total roughly 300 person-hours. After this initial study period, SCWA will sample fixed sites annually for the period of this biological opinion.

Sampling Frequency and Duration

Safe installation and operation of the traps at Mirabel Dam is dependent on river flow. Since 2000, the date of median cumulative catch for juvenile Chinook salmon and natural origin steelhead smolts has occurred during the first week of May. If river flow is conducive to safe and efficient operation, the Agency will attempt to install the trap annually after April 1 and operate continuously until catches decline in late June from 2009 to 2023.

Since 2000, less than one percent of observed adult Chinook salmon have passed the Dam site before September 1. Peak immigration typically occurs from October 15 to November 15. SCWA will operate the video counting system at Mirabel Dam annually from September 1 until high-flow or low water demand necessitates deflation of the dam in late fall from 2009-2023.

Installation date and operation of the screw trap in Dry Creek depends on flow and releases of steelhead smolts from Don Clausen Hatchery. Annually, SCWA will attempt to install the Dry Creek trap by April 15 and operate it until catches decline to near zero in late summer (September 1) from 2009-2018. SCWA will also operate fry traps from May 1 to July 1 during a two-year pilot study 2009-2010.

SCWA will conduct annual (2009-2023) juvenile abundance surveys on the mainstem of Dry Creek in conjunction with USACE Warm Springs Dam inspections. Dam inspections typically occur in September.

Reporting and Review
Because trapping and juvenile survey methods are untested in Dry Creek, SCWA will convene annual review meetings during the pilot study period with NMFS and CDFG before the sampling season begins in February 2009 and 2010. All data collected at Mirabel/Wohler and Dry Creek will be summarized in annual reports. These data, along with summaries will be forwarded to NMFS and CDFG within nine (9) months of each year's cessation of sampling. The aforementioned research and monitoring program can be adapted in consultation with NMFS and CDFG pending the results of the two-year pilot study.

6. *Funding Assurances for Purposes of Consistency Determination for CESA*[76]

SCWA shall provide security (Security), in a form and an amount to be approved by DFG, to cover all costs of monitoring and management of the Russian River estuary, and for monitoring, management and construction of habitat enhancement projects in Dry Creek, and the tributaries to Dry Creek, as specified in Sections [X 2.1.1], [X 2.2-2.4,], [X 3.1.1 and 3.1.2] and Section [X 4.3] (coho broodstock smolt program) of this Biological Opinion.

SCWA shall provide Security in three stages: (1) Stage 1 shall cover years 1-6 (2009-2013) and shall be provided to DFG prior to receiving take authorization for coho salmon from DFG (i.e., prior to issuance of a consistency determination); (2) Stage 2 shall cover years 7-9 (2014-2016) and shall be provided to DFG no later than January 1, 2013; and (3) Stage 3 shall cover years 10-15 (2017-2022) and shall be provided to DFG no later than January 1, 2016. Table 34 sets forth the monitoring, management, and construction activities included in each of the three Security-funding stages.

SCWA shall obtain DFG approval of the amount of the Security and language of the Security, which shall be consistent with this provision. The Security shall allow DFG to draw on the principal sum if DFG, at its sole discretion and in compliance with the provisions of the Security, determines that SCWA has failed to fully implement the required management, monitoring, and enhancement activities for that stage.

[76] This subsection has been added to help ensure that the RPA will be implemented consistent with the California Endangered Species Act.

Table 34. Monitoring, management, and construction activities included in each of the three stages of Security-funding.

Activity	Stage 1 Year 1-6 (2009-2013)	Stage 2 Year 7-9 (2014-2016)	Stage 3 Year 10-15 (2017-2022)
2.1.1 b) Annual design plans	All		
2.1.1 Adaptive Management	All		
2.2 Water Quality Monitoring	Year 1-6	Year 7-9	Year 10+[77]
2.3 Invertebrate Monitoring	Year 1-6	Year 7-9	Year 10+[77]
2.4 Fish Monitoring	Year 1-6	Year 7-9	Year 10+[77]
3.1.1 Dry Creek Enhancements	Group 1[78] planning, permitting, pre-monitoring, construction, and monitoring Group 2[79] planning, pre-monitoring, and permitting	Group 2 construction and monitoring Group 3[80] planning, pre-monitoring, and permitting	Group 3 construction and monitoring
3.1.2 Dry Creek Tributary Enhancements	All planning, pre-monitoring, permitting, construction, and monitoring	monitoring	Monitoring[77]
4.3 RRCBSP	Year 1-6	Year 7-9	Year 10-12 Year 13-15[77]

[77] Estuarine water quality, invertebrate, and fish monitoring for Stage 3 and coho smolt production in Years 13-15 shall be conducted if it is determined to be necessary pursuant to the terms of the Section X (Reasonable and Prudent Alternatives) of this Opinion.

[78] Group 1: at least 1 mile of modified stream channel providing excellent quality coho summer rearing habitat with a pool-riffle ratio between 1:2 and 2:1 and installation of 10 boulder clusters in reaches not otherwise enhanced.

[79] Group 2: additional 2 miles of modified stream channel providing excellent quality coho summer rearing habitat with a pool-riffle ratio between 1:2 and 2:1 and installation of 10 boulder clusters in reaches not otherwise enhanced.

[80] Group 3: additional 3 miles of modified stream channel providing excellent quality coho summer rearing habitat with a pool-riffle ratio between 1:2 and 2:1.

B. Effects of the RPA on CC Chinook salmon, CCC steelhead, and CCC coho salmon

The purpose of the Russian River Water Supply and Flood Control project is to control flooding within the watershed, to supply water to users within and outside of the watershed, and generate hydroelectric power. NMFS has concluded that the proposed actions described in Section III of this biological opinion operated in conjunction with the actions identified in Section X.A (*i.e.*, pursuit of changes to D1610, modifying management of estuarine water levels, habitat modifications to minimize adverse effects of high flow releases from WSD, further support for the RRCSCBP, and fish monitoring) constitute a reasonable and prudent alternative (RPA) to the proposed action that will achieve the project's purposes, avoid jeopardy to listed species and avoid the destruction or adverse modification of critical habitat.

The RPA actions identified in Section X.A include several distinct components. Each component in Section X.A must be implemented to ensure compliance with the RPA, to avoid jeopardizing CCC coho salmon and CCC steelhead, and to avoid adverse modification of designated critical habitat for these species.

1. Effects of the RPA on Steelhead Survival and Recovery

NMFS has analyzed the effects of the RPA (*i.e.*, the original project described in Section III as modified with the new elements described in section X.A) on CCC steelhead. This was done by examining the effects of the RPA when added to the species' baseline condition. This analysis is largely based on an evaluation of how habitat changes due to the project would likely affect survivorship of each life stage in the species' life cycle and the effect of these changes to populations of steelhead in the Russian River and to steelhead at the DPS scale.

As previously discussed in this opinion, the populations of steelhead in the Russian River have exhibited negative growth rates over the past several decades as the result of diverse impacts to the environment. Urban, residential, and agricultural developments, timber harvest, road construction, water supply and flood control management activities have had a collective adverse affect on the quality and quantity of steelhead spawning, rearing, and migratory habitats. Among these impacts to the species are the adverse effects of high flow releases from WSD and CVD on steelhead rearing habitat in 34 miles of the upper Russian River, the river's estuary, and 14 miles of Dry Creek. Artificially high inflows and SCWA's management of water levels in the estuary have diminished the quality and quantity of estuarine rearing habitat that has likely value for all populations of steelhead in the Russian River watershed. Notwithstanding these impacts, many tributaries to the Russian River that are unaffected by the project have continued to provide functioning, albeit degraded, steelhead spawning and rearing habitat (*e.g.*, NMFS 2007), and an estimated 1700 to 7000 wild steelhead have continued to annually return to spawn in the Russian River watershed (McEwan 2001). The DCFH has contributed to the abundance of steelhead in the watershed through the annual production and stocking of approximately 500,000 hatchery-reared steelhead smolts that are genetically similar to wild stock and are listed as part of the CCC steelhead DPS themselves. During the past five years, this smolt stocking program has resulted in an average annual combined total return of about 9,400 adult steelhead to the WSD hatchery and CVD fish facilities (DFG records for DCFH and CVFF).

When added to baseline conditions, the project as modified by the RPA will likely increase the abundance of returning wild spawned steelhead because:

1. Estuary water levels will be managed in the spring and summer to promote greater depths and lower salinity in the downstream most reaches of the Russian River. Such improvements will likely enhance the survival rate of small steelhead (<120 mm) that enter the estuary during spring and summer months. These changes, which will potentially benefit all populations of steelhead in the watershed, should enhance survival of juvenile steelhead as early as Year 1 of the 15 year project period. Increased juvenile survival in the estuary will promote increased production of steelhead smolts in the following year; this in turn will likely increase the numbers of returning adults 3 to 5 years after improvements in estuarine rearing habitat are achieved. Breaching after October 15 is anticipated to have discountable impacts on rearing steelhead because juvenile steelhead in the estuary will have grown to sufficient size by early fall to tolerate a highly saline estuary.

2. SCWA will enhance opportunities for adult steelhead to migrate past manmade barriers (*e.g.*, partially passable culverts) and/or improve the quality of rearing habitat in stream segments where survival is limited due insufficient pool depths, pool shelter, velocity refuge, or other factors limiting survival. Enhancement of passage opportunity will increase the likely numbers of adult steelhead that will spawn upstream of partial barriers. Implementation of five passage projects identified in Section X.A.3.2 (*i.e.*, removal of partial barriers on Grape, Wallace, Purrington, Crane, and Mill Creeks) will increase the duration of time that adult steelhead will be able to access approximately 47,000 m^2 of stream habitat, thereby increasing the likelihood that sufficient numbers of adult spawners can access these segments and maximize the production potential (*i.e.*, carrying capacity) above the former passage barriers. Likewise, the habitat restoration projects (*e.g.*, on Crane Creek, Grape Creek, and Wine Creek) will likely increase the potential numbers of juvenile steelhead that can rear within a unit area of these enhanced stream segments. For example, the three restoration projects identified on Crane, Grape, and Wine Creek have the potential to substantially enhance the quality of habitat in about 1800 m^2 of stream. Given the current degraded nature of these stream segments and that streams with good quality steelhead habitat support approximately 0.5 to 1.5 juvenile steelhead per m^2 **(**Lau 1984; Harvey and Nakamoto 1996; Smith 2007; NMFS unpublished data**)**, those enhancements would likely promote survival of roughly 800 wild juvenile steelhead (based on 25-50% improvement of habitat). Such efforts will provide benefits as early as Year 3 of the 15 year project period.

3. The creation of near-optimal quality, pool-riffle habitat distributed along at least six miles of Dry Creek and additional boulder clusters will afford rearing juvenile steelhead with much needed velocity refugia and greatly enhance the quality of both summer and winter rearing habitat for steelhead in Dry Creek. This effort will provide substantial benefits by the end of Year 5 and continue to improve rearing habitat through Year 12 of this 15 year project. Assuming that the six miles of new pool-riffle habitat averages 10 meters in width (a likely conservative, low estimate), at least 96,560 m^2 of high quality pool-riffle habitat will be created and interspersed over eight or more sites along Dry Creek. As described in Section VI.F.3, average density of juvenile steelhead in good quality rearing

habitat in coastal California streams is approximately 0.5 to 1.5 fish/m^2. Therefore, the six miles of enhanced pool-riffle habitat could yield the production of roughly 50,000 to 150,000 juvenile steelhead.

In addition, 20 large boulder clusters will create habitats for rearing juvenile steelhead in other areas of Dry Creek beyond the six miles of enhanced pool-riffle habitats. The production of juvenile steelhead that might occur as the result of the placement of boulder clusters is difficult to quantify. Raleigh *et al*. (1984) report that juvenile steelhead prefer streams with pool-riffle ratios of at least 1:4 (*i.e*., Raleigh et al. rate streams having ratios between 1:4 and 4:1 with Habitat Suitability Index values of 80% or higher). It seems reasonable that the footprint of each large boulder cluster and its associated pool and low velocity water will be at least 50 to 100 m^2. Assuming that the pool and velocity refuge provided by each boulder cluster is associated with four parts riffle habitat (*i.e*., a 50 m^2 pool formed by boulder clusters in association with 200 m^2 riffle habitat provides 250 m^2 of habitat), 20 boulder clusters should enhance 5,000 to 10,000 m^2 of steelhead rearing habitat. At 0.5 to 1.5 juvenile fish/m^2, this would provide for the additional production of 2500 to 15,000 juvenile steelhead.

4. Reduction of flows via changes in D1610 will promote enhancements in the quality of rearing habitat in the 34 mile segment between CVD and Cloverdale. Reducing the minimum flow requirement at Healdsburg from 185 to 125 cfs would enable SCWA and the Corps to reduce releases at CVD by 60 cfs throughout the summer. Such a change would reduce releases at CVD from about 230 cfs to about 190 cfs, and given the ongoing diversions in the mainstem, would reduce flows to about 160 to 200 cfs near Hopland and to approximately 145 to 180 cfs at Cloverdale (based on historic USGS Russian River gage records and an assumed linear reduction of flow between Hopland and Healdsburg). The interagency flow habitat study of the upper mainstem found that reducing summer releases at CVD from 275 to 190 cfs *increased* the availability of suitable juvenile steelhead rearing habitat at six of thirteen study sites, but *decreased* the quantity of suitable habitat at three sites[81] – a net benefit (Table 35). Moreover, this level of summer flow reduction appears to provide even greater gains in the abundance of optimal quality juvenile steelhead habitat (five sites were improved, and only one site had less optimal quality juvenile steelhead habitat). This reduction in summer flow releases would also conserve the coldwater pool in Lake Mendocino, thereby promoting the release of coldwater throughout the summer and early fall, rather than exhausting the coldwater pool during late summer**.** We estimate that SWRCB's minimum flow requirements under D1610 can be changed within a 6 to 8 year period. Petitions for interim changes to D1610 (*e.g*., annual Temporary Urgency Changes) will provide benefits to steelhead and possible coho rearing habitat in the estuary between Year 2 covered by this opinion and the permanent change to D1610.

Improved rearing habitats in the estuary, upper mainstem, Dry Creek and various tributaries will likely increase the survival of pre-smolt stages of steelhead that will in turn increase the production of steelhead smolts that enter the ocean. The resulting increase in smolt production should have a positive effect on the numbers of wild adult steelhead returning to the Russian

[81] Table 20 shows that the magnitude of the decrease at three sites is not outweighed by the gains at the other sites.

River. However, the exact increase in numbers of returning adults cannot be identified with great precision given that the survival of juvenile steelhead is dependent on many factors (*e.g.*, the timing and intensity of annual rainfall, stream flows, and oceanic conditions that affect marine survival of outmigrating smolts).

Table 35. Effects of reducing flow releases from 275 cfs at CVD on steelhead habitat at 13 study sites in the upper mainstem Russian River. Data from the Interagency Flow Habitat Study (Corps and SCWA 2004).

Life stage	Habitat Quality	Change in Flow Release (cfs)	Number of Sites		
			No change in Available Habitat	Habitat Gain	Habitat Loss
Steelhead Juvenile	Suitable	275 to 190	4	6	3
	Optimal	275 to 190	7	5	1
Steelhead Fry	Suitable	275 to 190	7	5	1
	Optimal	275 to 190	9	4	0
Steelhead Juvenile	Suitable	275 to 125	4	7	2
	Optimal	275 to 125	7	5	1
Steelhead Fry	Suitable	275 to 125	1	11	1
	Optimal	275 to 125	4	9	0

Nevertheless, the numbers of returning adults are a function of the numbers of out-migrating smolts, whether of wild or hatchery origin. Quinn (2005), who reviewed 215 published and unpublished studies of stage-specific survival rates for different species of salmon and steelhead, acknowledges wide ranges in the rate of smolt-to-adult survival, and he reports that average smolt-to-adult survival of steelhead is about 13%. A half century ago, intensive monitoring of steelhead in Waddell Creek (Santa Cruz County, CA) showed that age-2 smolts had an approximately 6% marine survival (Shapovalov and Taft 1954). Increased numbers of smolts produced as the result of implementation of this project's RPA will likely result in more steelhead returning to the Russian River than occurred under baseline conditions (*i.e.*, the effects of the RPA on steelhead abundance is a net increase in abundance, and hence growth in the river's steelhead populations).

In Section VIII, we found that the original project proposed by the Corps and SCWA constrained the ecological diversity of steelhead, because the high summer inflows and water level management practices in the estuary substantially reduce the quality of estuarine rearing habitat for YOY steelhead. With the RPA, water levels will be managed in a manner that should provide enhanced, good quality estuarine rearing habitat. Thus the project will not constrain the ecological diversity of steelhead.

We found that the original project would not likely cause any further adverse change in the spatial distribution of steelhead, and the RPA will also not adversely affect the spatial distribution of steelhead. The RPA's provision for the completion of at least five (5) tributary restoration projects may allow steelhead access to previously blocked habitats, depending upon the tributary restoration projects chosen (*i.e.*, the species spatial distribution would not be

enhanced if SCWA selected five channel habitat restoration projects in reaches already accessible to steelhead and coho salmon).

With implementation of the RPA there will continue to be some mortality or other forms of take of juvenile steelhead as the result of ongoing channel maintenance, flood control operations, stream flow changes associated with annual pre-flood and periodic dam inspections at CVD, deployment of the inflatable dam at Mirabel, entrainment of fishes into infiltration ponds at the Mirabel/Wholer diversion facilities during high flows, flow releases from WSD during the low flow period (June through October) prior to the completion of the planned habitat enhancements, and flow releases from CVD in years before D1610 flow requirements are changed. We have considered the effects of these various project elements in Section VI of this opinion. These impacts of the project operations have been generally ongoing at least since water storage commenced at WSD in October 1983 and D1610 was adopted in 1986. During the first five years of the project as defined by the RPA, loss of CCC steelhead due to the release of elevated flows in Dry Creek during the low flow season will be the same as recent years; however, it will be less in subsequent years because of planned habitat enhancements in Dry Creek. In addition to those effects of flood control and water supply operations, SCWA's seasonal monitoring of salmon and steelhead via the trapping and live release of a small percentage of juvenile salmonids migrating past the Mirabel dam and their monitoring of fishes in the estuary via seining have been ongoing for nine and five years, respectively. Some limited injury or mortality of juvenile steelhead may also occur as the result of RPA habitat enhancement work in the tributaries and in Dry Creek. SCWA will relocate juvenile steelhead from aquatic habitat in work sites. As described above in the biological opinion, NMFS anticipates injury and mortality to be limited to 3% of juvenile steelhead found at these sites. The injury and mortality associated with these project operations when combined with the benefits of the new project elements incorporated into the RPA (as described in Section X.A), is unlikely to reduce the likelihood of steelhead survival or recovery, but as discussed below, will likely increase chances for the species survival and recovery.

With the baseline annual return of several thousand wild and hatchery reared CCC steelhead to the Russian River, the consistent, albeit relatively low, return of adult CCC steelhead to other watersheds (*e.g.*, Napa River, Sonoma Creek, Salmon Creek, Lagunitas Creek, *etc.*), and the RPA's enhancement of tributary, upper mainstem and estuarine habitats in Years 2 through 4, it is highly unlikely that this species will become significantly reduced in abundance during the project's first five years prior to the habitat enhancements in Dry Creek. Given that the RPA will likely increase the recent historic abundance of steelhead populations in the Russian River beginning with enhancements of passage opportunity and rearing habitat in Dry Creek or Russian River tributaries during Years 1 to 3, enhancements of estuarine habitat beginning in Year 2, and substantial enhancement of rearing habitat in Dry Creek beginning in Year 5, followed by additional, major enhancements of steelhead rearing habitat in Dry Creek during Years 6, 8, 9, 11, and 12, the RPA will likely promote a positive trend in the growth rate of these populations. In addition, the RPA will not adversely affect the spatial diversity, ecological diversity, or genetic diversity of this species. For those reasons, we find that the RPA will not reduce appreciably the likelihood of the survival of CCC steelhead. The RPA will likely enhance many miles of rearing habitat for the potentially independent steelhead population in the Dry Creek watershed, and it will likely enhance estuarine rearing habitat that would benefit all

functionally independent, potentially independent, and dependent populations of steelhead in the Russian River watershed. These enhancements of habitat will likely increase the abundance and population growth rates of steelhead in the Russian River watershed. For those reasons, we find that the RPA will not reduce appreciably the likelihood of the recovery of CCC steelhead.

Incidental to its role of avoiding jeopardy of CCC steelhead, the RPA will help conserve CCC steelhead as this species responds to climate change. The genus *Oncorhynchus* has populated coastal streams of western North America since the Pliocene epoch two million years ago (Healey 1991). Over that period *Oncorhynchus* has persisted despite considerable variation in North America's climate, which has included several episodes of glaciation followed by global warming. As discussed in Section IV, Status of the Species, the recent warming of the earth's atmosphere will undoubtedly have some effects on both freshwater and marine ecosystems. The effects of global warming on the complex dynamics of coastal California marine ecosystems are uncertain and any adverse effects will likely be difficult to mitigate given their oceanographic scale. However, freshwater habitats of steelhead can be conserved and restored so that the survival of wild juvenile steelhead and the survival of post-spawned adult steelhead can be maximized. Given that ocean survival and adult returns are generally a small percentage of the numbers of outmigrating smolts, the production and conservation of large numbers of smolts in freshwater habitats should yield more returning adults than scenarios with much lower production of outmigrating smolts. The coldwater riverine habitats of the upper Russian River and Dry Creek produced by the RPA will create large quantities of coldwater rearing and spawning habitats of substantial value to steelhead. That abundant coldwater habitat will provide important refugia for steelhead populations that may become impacted by losses of summer rearing habitat due to climate driven droughts. Likewise the RPA's focus on restoring natural functioning conditions in the estuary will likely increase the abundance of steelhead smolts entering the ocean. Beyond the need to enhance freshwater steelhead production, the ability of CCC steelhead to respond successfully to climate change effects on both freshwater and marine ecosystems will be partly determined by their continued ability to adapt to changing conditions. To do that, the species and its populations will need to draw upon their inherent, natural genetic variation (Wapples *et al*. 2001; Crozier and Zabel 2006; Beechie *et al*. 2006). For that society will need to protect habitats that accommodate genetically diverse populations (e.g., protect both early running and late running individuals during the adult and juvenile migrations, protect the diverse timings and ages at which individual steelhead first spawn, and protect both anadromous and non-anadromous populations).

2. Effects of the RPA on Steelhead Critical Habitat

The new RPA actions will avoid adverse modification of designated critical habitat for steelhead, because:

1. Water levels in the estuary will now be managed to enhance the quality of the estuary as rearing habitat for steelhead in the spring and summer. Reduction of mainstem flows and a new water level management program that promotes natural closure of the lagoon or formation of a perched lagoon will likely yield conditions more similar to those that were present before the construction of WSD, CVD, and PVD, which created the need for water level management in the estuary. As described in Section

VI.G.1.b, recent historic management has contributed to elevated salinity levels, shallow depths, and localized reductions in the concentration of dissolved oxygen in the estuary. These management practices and resulting changes in water quality and depths have degraded the quality of critical habitat in the estuary. The RPA will ameliorate those adverse effects of the project by providing greater depths, reduced salinity, and localized higher dissolved oxygen concentrations. The enhanced depths may also yield cooler temperatures near the bottom of the estuary, conditions favored by steelhead.

2. The upper mainstem Russian River will have lower flows from mid-spring through early fall. This will enhance the quality of critical rearing habitat for steelhead. As explained in Section VI.F.4, water management under D-1610 has degraded critical rearing habitat for steelhead because the elevated summer flows released at CVD create excessive current velocities that limit the amount of rearing habitat for juvenile stages. Reducing the minimum flow requirement for the segment between the East Fork and Healdsburg by 60 cfs will promote lower releases in the vicinity of about 190 to 230 cfs. Tables 23 and 33 show that reducing summer releases at CVD from about 275 to 190 cfs (an 85 cfs reduction) will substantially enhance the value of the PCE of critical rearing habitat at several representative study sites in the upper mainstem. The proposed reduction of 60 cfs in summer releases has not been precisely studied; however, the interagency flow-habitat assessment suggests that appreciable gains in habitat are possible with lower summer releases in the vicinity of 190 to 230 cfs relative to the recent historic summer releases, which have generally been about 250 to 290 cfs. In addition, as noted above, lower summer releases at CVD will promote conservation of the coldwater hypolimnion in Lake Mendocino, which will increase the likelihood that water temperatures will remain good to excellent for steelhead throughout the summer. During average or above average water years, summer water temperatures near Cloverdale have historically been in the vicinity of about 20°C, which is higher than optimal for steelhead. During "below-normal water years", Lake Mendocino's hypolimnion has become severely depleted by historic water releases to the Russian River.
3. The impacts of high summer flow releases from WSD on the PCE of critical habitat for steelhead rearing in Dry Creek will be remedied by substantially enhancing the quantity and quality of rearing habitat for juvenile steelhead in the 14 mile segment downstream of WSD when flows range from about 110 to 175 cfs. To do this SCWA will create near-optimal quality, pool-riffle rearing habitat in six miles of Dry Creek for that range of flows. These enhancements will be distributed at eight separate sites and include improvements in the upper, middle and lower portions of Dry Creek. In addition, SCWA will install 20 boulder clusters that will provide velocity refuge and create rearing habitat in those areas that will not be engineered to provide near-optimal quality, pool-riffle sequences. The Corps will also work with SCWA to enhance winter habitat refuges at points along the margins of Dry Creek. The flood protection functions of WSD and the stabilization of banks through bioengineered approaches will promote the long-term stability of the habitat enhancements.

As described in section X.B.1, the construction of six miles of near optimal quality pool-riffle habitat in Dry Creek will create roughly 96,500 m^2 of high quality rearing habitat for steelhead.

As also described in the above section, the installation of 20 large boulder clusters in other stream reaches not subjected to major pool-riffle enhancements will provide velocity refuges and create roughly an additional 5000 to 10,000 m^2 of rearing habitat for juvenile steelhead at diverse locations throughout the remaining eight miles of Dry Creek affected by flow releases from WSD.

The plan for habitat enhancement will substantially improve rearing habitat throughout the 14 mile segment of stream and appreciably increase Dry Creek's carrying capacity for juvenile steelhead over that present during recent historic operations. The plan for five years of post-construction monitoring and adaptive management of all habitat enhancement sites will help ensure that the RPA creates good quality rearing habitat at each of the 28 habitat enhancement sites (8 major, pool-riffle enhancement zones plus 20 large boulder clusters), thereby avoiding adverse modification of rearing habitat in Dry Creek. We recognize that the science and application of stream habitat restoration and enhancement is highly complex and subject to the unpredictable influences of geology, hydrology (*e.g.*, floods), and biology. Therefore, despite the high likelihood that the implementation of the habitat enhancement plan will avoid adverse modification of critical habitat, we remain cautious and require engineering analysis, conceptual design, environmental impact assessment, and costing of a Dry Creek bypass pipeline for SCWA to convey its water supply from Lake Sonoma. A pipeline will be constructed in the unlikely event that it is found that unforeseeable, physical factors confound efforts to ameliorate the adverse affects of high summer and winter flow releases via modifications of the Dry Creek channel. A bypass pipeline would facilitate the reduction of summer flows, with resulting increases in available salmonid rearing habitat as described in Section VI.F.

3. Effects of the RPA on Coho Survival and Recovery

NMFS analyzed the effects of the RPA on CCC coho salmon in a manner similar to that which was done above for steelhead. The effects of the RPA were evaluated as conditions that will be added to the species' baseline condition. Much of this evaluation involves analysis of how habitat changes due to the project would likely affect survivorship of each life stage in the species' life cycle and the effect of those changes to the coho salmon population in the Russian River and to the CCC coho salmon ESU.

As previously discussed in the Environmental Baseline, the Russian River's coho salmon population is likely in an extinction vortex. The population has declined precipitously as the result of habitat degradation. The numbers of coho in the Russian River watershed are now so low that demographic instability and inbreeding threaten to cause further declines. Urban, residential, and agricultural developments, timber harvest, road construction, water supply and flood control management activities have had a collective adverse affect on the quality and quantity of coho salmon spawning, rearing, and migratory habitats in this watershed. Among these impacts to the species are the adverse effects of stream channelization and high flow releases from WSD on coho salmon rearing habitat in about nine miles of Dry Creek. SCWA's management of water levels in the estuary may also have diminished the quality and quantity of estuarine rearing habitat for the species. As previously discussed, most of the current production of coho salmon in the Russian River watershed is likely sustained by the RRCSCBP. However, this program is in its infancy, and to date, adult returns appear to be very low. In addition to that

program, low levels of natural reproduction produce returns of a few adult fish to a few streams that are not in the project area (*e.g.*, Green Valley Creek and Dutchbill Creek).

The project as modified by the RPA, when added to baseline conditions, will likely enhance the abundance, population growth rate, spatial distribution, and diversity of returning wild coho salmon. These population viability metrics will be enhanced because:

1. A new reservoir of genetically healthy and compatible, juvenile coho salmon will be reared at the WSD hatchery so that at least 10,000 smolts will be annually released into Dry Creek. This program of stocking genetically healthy and compatible hatchery smolts that have wild broodstock ancestry will compliment the wild broodstock fry and juvenile stocking program. The hatchery smolts will not require one year of rearing in Russian River tributaries and therefore will not be vulnerable to the high mortalities associated with droughts, water diversions, sedimentation and other threats to stream-rearing juvenile fish. We estimate that 10,000 smolts will have a return rate of about 1 to 3% (Sandercock 1991; DFG data for hatchery returns) and thus this new element of the program will help ensure that the RRCSCBP continues to have about 100 to 300 adult Russian River stock coho to breed each year. Given the very low abundance of the Russian River coho salmon population, and the potential for inbreeding depression and depensatory processes (*e.g.*, inbreeding and inability for adults to find mates), it is important that the RRCSCBP augment numbers of coho until such times as habitat is restored to several tributaries in the watershed and the abundance of natural spawning wild coho salmon is sufficient to avoid such threats to the population.

2. SCWA will enhance opportunities for adult coho salmon to migrate past manmade barriers (*e.g.*, partially passable culverts) and/or improve the quality of rearing habitat in stream segments where survival is limited due insufficient pool depths, pool shelter, velocity refuge, or other factors limiting survival. Enhancement of passage opportunity will increase the likely numbers of adult coho salmon that will spawn upstream of partial barriers. Implementation of five passage projects identified in Section X.A.3.2 (*i.e.*, removal of partial barriers on Grape, Wallace, Purrington, Crane, and Mill Creeks) will increase the duration of time that adult coho salmon will be able to access approximately 47,000 m^2 of stream habitat, thereby increasing the likelihood that sufficient numbers of adult spawners can access these segments and maximize the production potential (*i.e.*, carrying capacity) above the former passage barriers. Likewise, the habitat restoration projects (*e.g.*, on Crane Creek, Grape Creek, and Wine Creek) will likely increase the potential numbers of juvenile coho salmon that can rear within a unit area of these enhanced stream segments. For example, the three restoration projects identified on Crane, Grape, and Wine Creek have the potential to substantially enhance the quality of habitat in about 1800 m^2 of stream. Given the current degraded nature of these three stream segments and that streams with good quality coho salmon habitat support approximately 0.3 juvenile coho salmon per m^2 (Brakensiek 2002; Del Real *et al*. 2008; DFG unpublished data), those enhancements would likely promote the additional survival of roughly 240 wild juvenile coho salmon (based on 25-50% improvement of habitat). Computation of

additional production associated with passage enhancements is dependent on the numbers of additional spawners that are able to access the 47,000 m^2 above the partial barriers. Passage improvements and rearing habitat enhancements will provide benefits by Year 3 of the 15 year project period.

3. The creation of high quality pool-riffle habitat along at least six miles of Dry Creek and additional habitats created by large boulder clusters will afford rearing juvenile coho salmon with much needed velocity refugia and greatly enhance the quality of both summer and winter rearing habitat for coho salmon in Dry Creek. This effort will provide substantial benefits by the end of Year 5 and continue to improve coho rearing habitat through Year 12 of this 15 year project. Assuming that the six miles of new pool-riffle habitat is at least 10 meters in width (a likely conservative, low estimate), at least 96,560 m^2 of high quality pool-riffle habitat will be created and interspersed over eight or more sites along Dry Creek. As noted above, average density of juvenile coho in good quality habitat is approximately 0.3 fish/m^2. Therefore, the six miles of enhanced pool-riffle habitat could yield the production of roughly 30,000 juvenile coho salmon.

   In addition, 20 large boulder clusters will create habitats for rearing juvenile coho salmon in other areas of Dry Creek beyond the six miles of enhanced pool-riffle habitats. The production of juvenile coho salmon that might occur as the result of the placement of large boulder clusters is difficult to quantify. McMahon (1983) reports that juvenile coho salmon prefer streams with about one-third to two-thirds pool habitat (*i.e*., McMahon rates streams with 33 to 67 percent pools as having Habitat Suitability Index values of 80% or higher). As described above for steelhead, it seems reasonable that the footprint of each large boulder cluster and its associated pools and low velocity water will be at least 50 to 100 m^2. Assuming that the pool and velocity refuge provided by each boulder cluster is associated with two parts riffle habitat, then 20 boulder clusters should enhance 3000 to 6000 m^2 of juvenile coho salmon habitat. At 0.3 juvenile fish/m^2, this would provide for the additional production of 900 to 1800 juvenile coho salmon in Dry Creek.

4. Estuary water levels will be managed to promote greater depths and lower salinity in the downstream most reaches of the Russian River. Such improvements will likely enhance the survival rate of small coho salmon (<120 mm) that enter the estuary during spring and summer months. These changes may enhance survival of juvenile coho salmon as early as Year 1 of the 15 year project period. Reduction of flows via changes in D1610 will also promote enhancements in the quality of rearing habitat in the Russian River estuary. We estimate that SWRCB's minimum flow requirements under D1610 can be changed within a 6 to 8 year period. Petitions for interim changes to D1610 (e.g.,annual Temporary Urgency Changes) will provide benefits to possible coho rearing habitat in the estuary between Year 2 covered by this opinion and the permanent change to D1610. Increased juvenile survival in the estuary will promote increased production of coho salmon smolts in the following year; this in turn will likely increase the numbers of returning adults two to three years after improvements in estuarine rearing habitat are achieved. Fall breaching (after October

15) is unlikely to have adverse effects on coho salmon rearing in the estuary. As described in the biological opinion, coho salmon are expected to migrate upstream out of estuaries in the fall. In addition, by October 15 juveniles are likely to have grown to sufficient size to tolerate salt water conditions.

5. The RRCSCBP will have secure funding for genetics management of the wild broodstock and for monitoring of stocked juvenile fishes planted in Russian River tributary streams. Proper genetics management and knowledge of the survival, abundance, distribution, and migration timing of program fishes is essential for the long-term success of the RRCSCBP in reestablishing natural coho salmon populations within the Russian River basin. In addition, the installation of an EWSL will help ensure that the wild coho captive broodstock program is not threatened by catastrophic losses due to a water supply failure.

Improved rearing habitats in the estuary, Dry Creek, and various tributaries will likely increase the survival of pre-smolt stages of coho salmon that will, in turn, increase the production of coho smolts that enter the ocean. The resulting increase in smolt production should have a positive effect on the numbers of wild adult coho salmon returning to the Russian River. However, the exact increase in numbers of returning adults cannot be identified with great precision given that the survival of juvenile coho salmon is dependent on many factors (*e.g.*, the timing and intensity of annual rainfall, stream flows, and oceanic conditions that affect marine survival of outmigrating smolts).

Nevertheless, the numbers of returning adults are a function of the numbers of out-migrating smolts, whether of wild or hatchery origin. Sandercock (1991) suggests that smolt to adult survival of coho salmon is generally about 3 to 5%, although higher and lower returns are reported. Increased numbers of smolts produced as the result of implementation of this project's RPA will likely result in more coho salmon returning to the Russian River than would return under the original proposed project (*i.e.*, the effects of the RPA on coho abundance is a net increase in abundance). Increased production of coho salmon in habitats improved by the RPA will help offset losses caused by depensatory processes and inbreeding associated with the extremely low population numbers of Russian River coho salmon. Furthermore, given the near extirpation of the species in this watershed, the RPA has good potential to reverse the negative trend in population growth to a positive trend.

In Section VIII, we found that the original project proposed by the Corps and SCWA constrained the genetic and ecological diversity of coho salmon, because it maintains a status quo that inhibits growth of a population so low that depensatory mechanisms threaten the population's genetic diversity. With the restoration of habitats in Dry Creek's mainstem and tributaries, improvements in estuarine water level management, the annual stocking of 10,000 genetically compatible coho salmon smolts, and assurances of ongoing genetic management and population monitoring within the RRCSCBP, the RPA should improve population growth and decrease risks associated with reduced genetic and ecological diversity.

We also found that the original project would likely adversely affect the spatial distribution of coho salmon, because it virtually precludes Dry Creek as useable rearing habitat for this species. The RPA will promote expansion of the spatial distribution of coho salmon because it will

substantially enhance the suitability of both Dry Creek and its tributaries as rearing habitat for coho. In addition the RPA funding support for genetics management, an emergency water supply pipeline at Warm Springs Hatchery, and population monitoring in the field for the RRCSCBP will enable cooperating agencies to rear and plant genetically healthy and compatible Russian River-stock coho into streams where Russian River coho have been extirpated.

With implementation of the RPA there will continue to be some mortality or other forms of take of juvenile coho salmon as the result of ongoing channel maintenance in the mainstem, flood control operations at WSD, deployment of the inflatable dam at Mirabel, entrainment of fishes into infiltration ponds at the Mirabel/Wholer diversion facilities during high flows, and flow releases from WSD during the low flow period (June through October) prior to full implementation of the Dry Creek habitat enhancements in 2020. We have considered the effects of these various project elements in Section VI of this opinion. These impacts of the project operations have been generally ongoing at least since water storage commenced at WSD in October 1983 and D1610 was adopted in 1986. Loss of CCC coho salmon due to the release of elevated flows in Dry Creek during the low flow season will be similar to that in recent years during the first five years of the RPA; however, it will be less in subsequent years because of planned habitat enhancements in Dry Creek. In addition to those effects of flood control and water supply operations, SCWA's seasonal monitoring of salmon and steelhead via the trapping and live release of a small percentage of juvenile salmonids migrating past the Mirabel dam and SCWA's monitoring of fishes in the estuary via seining have been ongoing for nine and five years, respectively. Some limited injury or mortality of juvenile coho salmon may also occur as the result of RPA habitat enhancement work in the tributaries and in Dry Creek. SCWA will relocate juvenile coho salmon from aquatic habitat in work sites. As described above in the biological opinion, NMFS anticipates injury and mortality to be limited to 3% of juvenile salmonids found at these sites. Because we anticipate substantially greater numbers of coho salmon in the system as the result of the RPA, the actual loss of individual juvenile coho salmon will probably be greater than that under recent operations. However, the loss or mortality of some coho salmon due to implementation of the RPA when combined with the increased survival of other individuals due to new project elements in the RPA (as described in Section X.A), will likely substantially improve population growth and abundance and decrease diversity risks to the Russian River coho salmon population.

Given that the RPA will likely increase the abundance of the coho salmon population in the Russian River beginning in Year 1 with estuarine habitat enhancements and annual stocking of 10,000 genetically compatible smolts, and the enhancement of passage opportunity and rearing habitats in tributaries by end of Year 3, the major enhancements of rearing habitat in Dry Creek between Years 5 and 12, the RPA will likely promote a positive trend in the growth rate of the Russian River coho salmon population. In addition, the annual funding of the genetics management and field monitoring for the RRCSCBP and the replacement of the emergency water supply line for the Warm Springs Hatchery will help ensure the viability of the RRCSCBP for the duration of the Project. With support for genetic analysis, field monitoring of stocked program fish, the implementation of a smolt stocking component, provision of an emergency back-up water supply line, and substantial habitat enhancements in Dry Creek and its tributaries, it is likely that Russian River stock coho will not be extirpated during the 15 year Project. Indeed, it is unlikely that the RPA will appreciably reduce the numbers of coho in the watershed,

but rather it will likely increase the abundance of the Russian River coho salmon population, and enhance its habitats in both the Dry Creek watershed and estuary. The RPA should also not adversely affect the spatial diversity, ecological diversity, or genetic diversity of this species. For those reasons, we find that the RPA will not jeopardize the survival of CCC coho salmon. Beyond not jeopardizing the species, these enhancements of habitat and the stocking of smolts from the RRCSCBP will likely increase the abundance and population growth rates of coho salmon in the Russian River watershed. Therefore, we find that the RPA will not reduce appreciably the likelihood of the recovery of CCC coho salmon. In addition, for the reasons described above for steelhead, the RPA will likely also help the Russian River coho salmon population respond to climate change.

4. Effects of the RPA on Coho Salmon Critical Habitat

The new RPA actions will avoid adverse modification of designated critical habitat for coho salmon, because:

1. The adverse modification of critical rearing habitat due to high summer flow releases from WSD will be remedied by substantially enhancing the quantity and quality of rearing habitat for juvenile coho salmon in the 14 mile segment downstream of WSD when flows range from about 110 to 175 cfs. To do this SCWA will create near-optimal quality, pool-riffle rearing habitat in six miles of Dry Creek for that range of flows. These enhancements will be distributed at eight separate sites and include improvements in the upper, middle and lower portions of Dry Creek. In addition, SCWA will install 20 boulder clusters that will provide velocity refuge and create rearing habitat in those areas that will not be engineered to provide near-optimal quality, pool-riffle sequences. The Corps will also work with SCWA to enhance winter habitat refuges for coho salmon at points along the margins of Dry Creek. The flood protection functions of WSD and the stabilization of banks through bioengineered approaches will promote the long-term stability of the habitat enhancements.

2. Water levels in the estuary will be managed to enhance the quality of the estuary as rearing habitat for coho salmon and steelhead. Reduction of mainstem flows and a new water level management program that promotes natural closure of the lagoon or formation of a perched lagoon will likely yield conditions more similar to those that were present before the construction of WSD, CVD, and PVD, which created the need for water level management in the estuary. The RPA will provide greater depths, reduced salinity, localized higher dissolved oxygen concentrations, and it may yield cooler temperatures near the bottom of the estuary, conditions favored by coho salmon.

As described in Section X.B.3, the construction of six miles of near-optimal quality pool-riffle habitat in Dry Creek will create roughly 96,500 m^2 of high quality rearing habitat for coho salmon. As also described in the above section, the installation of 20 large boulder clusters in stream reaches not benefited by major pool-riffle enhancements will provide velocity refuges and create roughly an additional 3000 to 6000 m^2 of rearing habitat for coho salmon at diverse locations throughout the remaining eight miles of Dry Creek affected by flow releases from WSD.

The plan for habitat enhancements will substantially improve coho salmon rearing habitat throughout the 14 mile segment of stream and appreciably increase Dry Creek's carrying capacity for juvenile coho salmon over that present during recent historic operations. The plan for five years of post-construction monitoring and adaptive management of all habitat enhancement sites will help ensure that the RPA creates good quality rearing habitat at each of the 28 habitat enhancement sites (8 major, pool-riffle enhancement zones plus 20 large boulder clusters), thereby avoiding adverse modification of coho salmon rearing habitat in Dry Creek. As stated under the discussion of steelhead habitat enhancements, we recognize that the science and application of stream habitat restoration and enhancement is highly complex and subject to the unpredictable influences of geology, hydrology (*e.g*., floods), and biology. Therefore, despite the high likelihood that implementation of the habitat enhancement plan will avoid adverse modification of critical habitat, we remain cautious and require engineering analysis, conceptual design, environmental impact assessment, and costing of a Dry Creek bypass pipeline for SCWA to convey its water supply from Lake Sonoma. A pipeline will be constructed in the unlikely event that it is found that unforeseeable, physical factors confound efforts to ameliorate the adverse affects of high summer and winter flow releases via modifications of the Dry Creek channel. A bypass pipeline would facilitate the reduction of summer flows, with resulting increases in available salmonid rearing habitat as described in Section VI.F.

5. Effects of the RPA on Chinook salmon survival and recovery

NMFS has analyzed the effects of the RPA on CC Chinook salmon. This was done similar to what was done above for steelhead and coho salmon. As previously discussed in this opinion, the population of Chinook salmon in the Russian River appears to be at least stable, and may be increasing, although the reduced 2007 returns warrant caution. Water diversions, the confinement of the river channel, limited riparian vegetation, and ongoing sedimentation from roads, agriculture, and other developments remain important unresolved threats to the success of the Russian River Chinook salmon.

When added to the baseline, the RPA will initially have only limited impacts on the abundance of Chinook salmon, and is unlikely to affect the species growth rate, distribution, or diversity. As the RPA's various new project components are implemented over time, Chinook salmon juvenile abundance, and perhaps the species' growth rate, are anticipated to increase because:

1. Losses to Chinook salmon resulting from the original project elements will be relatively minor as described above in the biological opinion. These losses are unlikely to adversely affect the population's growth rate because they likely affect only a very small portion of the total egg, alevin, and juveniles produced in the river.
2. The new elements of the RPA are unlikely to adversely affect large numbers of Chinook salmon. The perched lagoon created by adaptive sandbar management at the mouth of the Russian River is anticipated to allow migrating adults and smolts to enter and exit the watershed via the overflow channel. There may be some increase in predation on Chinook salmon entering or exiting the lagoon due to the relatively confined space provided by the overflow channel. NMFS expects that most smolts will be migrating during high spring flows prior to closure of the bar in most years, and losses to the population will be relatively minor. Similarly, most adults migrate from mid October

through early winter, and NMFS anticipates the bar will be open to ocean tides in most years due to high flows and/or breaching.

3. The RPA's eventual reduction in the mainstem Russian River and enhancement of low velocity refuge habitat in Dry Creek are anticipated to be beneficial to fry and juvenile Chinook salmon, as described in Tables 22 and 23 in the preceding biological opinion. Thus, survival of the fry and juvenile components of the population should increase, and for the reasons described above for steelhead, the RPA will probably also help the Russian River Chinook salmon population respond to climate change.

6. Effects of the RPA on Chinook salmon Critical Habitat

The RPA will avoid adverse modification of designated critical habitat for Chinook salmon, because:

1. The migratory corridor PCE of critical habitat for adult Chinook salmon appears to be enhanced by the elevated regulated flows that will begin annually on October 15. Under the RPA, the Russian River mainstem will not serve as a migratory corridor for upstream migrating adult Chinook salmon between late August and mid-October (as has occurred under D1610). However, functional migratory habitats for adult CC Chinook salmon at this time are not essential to population viability in the Russian River, given that numbers of fishes entering the river prior to October 1 is minimal, early migrants into the river are exposed to prolonged angling pressure and high water temperatures, early migrants in the Russian River have been generally unable to access spawning habitats until after October 15, and high water temperatures in the mainstem Russian River and major tributaries during late August and September preclude early spawning and successful egg incubation of Chinook salmon.
2. Because they migrate to the ocean in the spring of their first year, rearing juvenile Chinook salmon do not contend with the artificially high summer flows that limit available rearing habitat for the other Federally listed salmonid species. Although channel maintenance activities under the RPA will likely have some adverse effect on spawning and rearing habitats for Chinook salmon, these effects will likely be minor because each year, channel maintenance will affect only a small portion (less than 1 mile) of the 94 mile long main stem Russian River, which effectively supports rearing habitat for juvenile Chinook salmon along its entire length and spawning habitat at riffles along the approximately 58 mile segment upstream from Healdsburg. The extent of habitat loss for rearing Chinook salmon in Dry Creek due to the RPA's channel maintenance activities is minor, confined to small, fixed locations, and further discountable given the availability of rearing habitat for this species in the main stem Russian River.
3. Changes to migration habitat in the Russian River estuary are unlikely to impair egress from, or entrance to, the Russian River. Predation from marine mammals may increase due to the relatively confined space of the outflow channel when compared to a tidal channel. However, as described in Section V, predation from marine mammals in the estuary is expected to have only minor effects on salmonid population abundance.
4. Changes in the value of estuarine habitat for juveniles transitioning to the marine environment are anticipated to be minor because: 1) in many years the perched lagoon will not be created until after the bulk of Chinook salmon smolts have entered the ocean, and 2) as described above in the biological opinion, most juveniles are expected to be

ready (based on size) to enter the ocean when they arrive at the estuary, reducing their need for transitioning habitat. Furthermore, the timing of the closure or partial closure will approximate the natural closure of the estuary that occurred prior to the development of water projects in the Russian River.

XI. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are nondiscretionary, and must be undertaken by the Corps and SCWA for the exemption in section 7(o)(2) to apply. The Corps and SCWA have a continuing duty to regulate the activity covered by this incidental take statement. If the Corps or SCWA: (1) fail to assume and implement the terms and conditions, or (2) fail to require any permittee to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to any permit, grant document, or contract, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps and SCWA must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement (50 CFR §402.14(i)(3)).

This incidental take statement is applicable to all activities related to the Corps and SCWA Russian River Flow Management Project pursuant to the RPA described in this opinion. Unless modified, this incidental take statement does not cover activities that are not described and assessed within this opinion.

A. Amount or Extent of Take

Certain RPA elements are unlikely to result in take:

- Pursuit of lower D1610 Minimum Flows
- Project Scoping and Preliminary Design of a Water Delivery Pipeline

These elements include planning, design, and public scoping involving no disturbance of listed salmonids or their habitats.

The remaining RPA elements (the original proposed projects and modifications described above in section X.) are anticipated to result in take. As described in the preceding biological opinion and RPA, the number taken is likely to be small in many instances. The precise number of salmonids that are likely to be taken by the Project cannot always be accurately quantified because salmonids: (1) are relatively small (especially as eggs, alevins, and juveniles); (2) live in aquatic environments where visibility is often low, hiding cover often available, and predators

feed; (3) migrate long distances in short periods of time during some life history stages; and (4) naturally fluctuate in number between years due to short term environmental variation and other factors. In cases where NMFS cannot specify a quantity of individuals that are expected to be incidentally taken by the action, incidental take must be quantified using a surrogate as an extent. Thus, NMFS has used habitat impacts as a surrogate for numbers of salmonids expected to be incidentally taken. Habitat impacts are a reasonable surrogate as we have identified habitat impacts and demonstrated their link to incidental take of listed salmonids in the biological opinion and RPA.

The following quantification of incidental take is based on implementation of the proposed action as modified by the elements of the RPA. NMFS anticipates the following take from the combination of proposed action and RPA project elements:

1. Water Supply releases from WSD and CVD

a. Dry Creek

In our analysis of the effects of the originally proposed project (Section VI.F), we estimated that the mainstem Dry Creek channel had the potential to support 90,000 to 270,000 juvenile steelhead if summer releases were maintained at about 45 cfs. We estimated that approximately 75% of that potential production is lost as the result of sustained high releases in the range of 120 to 130 cfs during the summer period. Losses are even higher when flows are sustained at even higher levels. In that analysis of the originally proposed project, we also found that, because the coho salmon population in the Russian River is so low, the numbers of coho that are likely killed as the result of high summer flows in Dry Creek is in the vicinity of about 2,800 juvenile fish. However, because of the need to establish enforceable, measureable levels of anticipated take, NMFS will not use these numbers in describing the amount of anticipated take in this incidental take statement. The use of discrete numbers of individual fish for the incidental take statement is problematic because: 1) they are rough estimates used in the biological opinion to make relative comparisons, 2) monitoring of juvenile coho salmon and steelhead swept downstream is precluded by the difficulty in observing (or capturing all) these small fish in their habitat, 3) take levels will vary depending upon water year type and the flows released from WSD, and 4) fish loss is expected to diminish over time as interim channel improvements are installed, creating areas where juvenile fish can escape high velocity flows.

Instead, NMFS will use both WSD flow release data and anticipated enhancements to Dry Creek described in the RPA as surrogates for estimating numbers of fish killed, and as a means to identify if implementation of the action and RPA is exceeding levels of anticipated take. In this opinion, we found that large numbers of salmonids are likely adversely affected by the proposed "status quo" summer flow releases at WSD. As the RPA is implemented, channel improvements are scheduled to be placed in the mainstem of Dry Creek starting in year five[82]. Given that salmonid rearing habitat degrades steadily as flow rises above 90 cfs, it is prudent and reasonable to not augment releases beyond recent levels (past fifteen years) until the RPA's Dry Creek habitat enhancement measures are fully constructed and shown to provide good quality steelhead and coho salmon rearing habitat. Under the RPA, flow releases during summer months are

[82] The first set of channel improvements in the mainstem are not scheduled to be fully installed until year six.

expected to be similar to operations that have occurred during the past fifteen years. As the channel improvements described in the RPA occur, the amount of incidental take will decrease, starting in year five and culminating in year 13 when incidental take from WSD flow releases is expected to become discountable.

To that end, NMFS will use the monthly median flow released from WSD during the months of June, July, August, September and October of the next fifteen years as one of the surrogates for numbers of fish lost due to high velocity summer flows. Given that water supply releases under the RPA will be similar to those practiced during the past fifteen years, NMFS analyzed those flow releases in the biological opinion and assumes the next fifteen years of WSD releases would be similar to the past fifteen years. We used the flow levels we analyzed in Dry Creek (47, 90, and 130 cfs) as references for relative impact and examined the frequency distribution of flows during the previous fifteen years (Table 15). We used this frequency distribution as part of the basis for describing anticipated take. Based on the median monthly summer flow releases for water years 1993 through 2006[83], NMFS expects that the anticipated numbers of juvenile salmonids swept downstream into inhospitable conditions would be exceeded if during the next twelve years (the time prior to the completion of Dry Creek habitat enhancements affording good habitat conditions for WSD releases of 110 to 175 cfs):

- Monthly median flow immediately below WSD[84] during low flow months (June, July, August, September, and October) exceeds 160 cfs in more than one month of the total 60 low flow months (five months per year for 12 years) covered by the first 12 years of this opinion, and
- Monthly median flow immediately below WSD during low flow months (June, July, August, September, and October) exceeds 140 cfs in more than 5 months of the total 60 low flow months (five months per year for 12 years) covered by the first 12 years of this opinion, and
- Monthly median flow immediately below WSD during low flow months (June, July, August, September, and October) exceeds 120 cfs in more than 16 months of the total 60 low flow months (five months per year for 12 years) covered by the first 12 years of this opinion, and
- Monthly median flow immediately below WSD during low flow months (June, July, August, September, and October) exceeds 105 cfs in more than 34 months of the total 60 low flow months (five months per year for 12 years) covered by the first 12 years of this opinion.
- Monthly median flow immediately below WSD during low flow months (June, July, August, September, and October) exceeds 175 cfs during Years 13-15 covered by this opinion (assuming that the habitat enhancements described in the RPA and below are implemented and shown to be effective and support good production of juvenile steelhead and coho salmon by end of Year 12).

[83] We were unable to use data for water year 2007 because October 2007 is part of Water year 2008, which is provisional and not available at this time

[84] Monthly median flows will be determined using provisional data from USGS Gage 11465000 located immediately downstream of the outlet structure complimented with other provisional discharge data for WSD.

These values represent a frequency distribution for monthly median flows that is equivalent to the preceding fifteen years of monthly medians for the months indicated. We assume that consistent with the RPA, SCWA will enhance habitat in Dry Creek by end of year 12 covered by this opinion such that releases of 110 to 175 cfs will not be deleterious to salmonids in Dry Creek. If habitat enhancements are not implemented or monitoring indicates that the habitat enhancements are not effective, then take of listed steelhead and coho salmon may be exceeded.

In addition to limitations on flow, the anticipated numbers of juvenile salmonids swept downstream into inhospitable conditions would be exceeded if:

- By the end of Year 3 the Corps and SCWA have not completed five of the ten habitat restoration projects within Russian River or Dry Creek tributaries as identified in the RPA, Section X.A.3.1.2.

- By the end of Year 6 the Corps and SCWA have not created and enhanced at least one mile of the mainstem of Dry Creek with high quality pool-riffle sequences with a pool-riffle ratio ranging from 1:2 to 2:1 and with pools having the following characteristics:
  Size - 10 to 80 m^3 or 50 to 250 m^2
  Depth - ranges from 2 to 4 feet
  Substantial areas with mean column velocities of 0.1 to 0.2 ft/s
  Cover - more than 30% of the pool bottom obscured due to depth, surface turbulence, or presence of structures such as logs, debris piles, boulders, or overhanging banks and vegetation
  Placement- enhanced stream channel distributed at a minimum of two (2) different locations

- By the end of Year 6 the Corps and SCWA have not placed 10 boulder clusters in the mainstem of Dry Creek as described by Flosi *et al*. (1998).

- By the end of Year 9 the Corps and SCWA have not created and enhanced at least three (3) miles of the mainstem of Dry Creek with high quality pool-riffle sequences with a pool-riffle ratio ranging from 1:2 to 2:1 and with pools having the following characteristics:
  Size - 10 to 80 m^3 or 50 to 250 m^2
  Depth - ranges from 2 to 4 feet
  Substantial areas with mean column velocities of 0.1 to 0.2 ft/s
  Cover - more than 30% of the pool bottom obscured due to depth, surface turbulence, or presence of structures such as logs, debris piles, boulders, or overhanging banks and vegetation
  Placement- enhanced stream channel distributed at a minimum of four (4) different locations

- By the end of Year 9 the Corps and SCWA have not placed 20 boulder clusters in the mainstem of Dry Creek as described by Flosi et al. (1998).

- By the end of Year 12 the Corps and SCWA have not created and enhanced at least six (6) miles of the mainstem of Dry Creek with high quality pool-riffle sequences with a pool-riffle ratio ranging from 1:2 to 2:1 and with pools having the following characteristics:

  Size - 10 to 80 m^3 or 50 to 250 m^2
  Depth - ranges from 2 to 4 feet
  Substantial areas with mean column velocities of 0.1 to 0.2 ft/s
  Cover - more than 30% of the pool bottom obscured due to depth, surface turbulence, or presence of structures such as logs, debris piles, oulders, or overhanging banks and vegetation
  Placement- enhanced stream channel distributed at a minimum of eight (8) different locations

b. Mainstem Russian River

Similarly, NMFS has used a frequency distribution of monthly medians of the daily mean flow in the mainstem during the previous fifteen years as a surrogate for anticipated take of listed salmonids in the mainstem due to high summer flow releases during the next fifteen years. However, criteria for anticipated take associated with high flow releases from CVD is more complicated because: 1) June and October are months when flow in the mainstem can be heavily influenced by natural events (spring runoff in June and reduction in evapotranspiration in October), 2) summer releases from CVD and minimum flows at Healdsburg are highly dependent on water year type, and 3) the RPA calls for changes in minimum flow requirements for the Russian River so that releases from CVD can be reduced. Therefore, our estimate of the number of listed salmonids we anticipate swept downstream and killed due to high summer flow releases from CVD is focused only on the months of July, August, and September and it considers water year type and whether SWRCB minimum flow requirements are changed. Based on the last fifteen years of record, NMFS expects that incidental take may be exceeded during, July, August, or September if:

<u>Prior to any modification of flow requirements stipulated in D1610</u>

In normal water years:

- Monthly median flow immediately below CVD[85] during low flow months (July, August, and September) exceeds 335 cfs in more than one month of the total 45 low flow months (three months per year for fifteen years) covered by this opinion, and
- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 300 cfs in more than 10% of the total number of low flow months in normal water years occurring over the fifteen years covered by this opinion, and

[85] Montly median flow will be determined by USGS gauge 11462000, which is located immediately downstream of CVD. NMFS recognizes that SCWA and the Corps operate CVD using instantaneous provisional discharge data at CVD. Final corrected USGS data are not computed until months after releases are made. SCWA and the Corps will make best efforts to achieve flow objectives utilizing real-time (provisional) discharge data from both USGS 11462000 and the Corps data for CVD.

- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 260 cfs in more than 50% of the total number of low flow months in normal water years occurring over the 15 years covered by this opinion.

In Dry water years:

- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 230 cfs in more than one month for all low flow months occurring in dry water years over the 15 years covered by this opinion, and
- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 200 cfs in more than 50% of the total number of low flow months in dry water years occurring over the 15 years covered by this opinion.

<u>After modification of flow requirements stipulated in D1610</u>
(We assume minimum flow requirements between the East Fork and Healdsburg can be reduced by at least 60 cfs in normal water years)

Normal water years:

- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 275 cfs in more than one month of the total 45 low flow months (three months per year for ten years) covered by this opinion, and
- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 240 cfs in more than 10% of the total number of low flow months in normal water years occurring over the 15 years covered by this opinion, and
- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 200 cfs in more than 50% of the total number of low flow months in normal water years occurring over the 15 years covered by this opinion.

Dry water years:

- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 230 cfs in more than one month for all low flow months occurring in dry water years over the 15 years covered by this opinion, and
- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 200 cfs in more than 50% of the total number of low flow months in dry water years occurring over the 15 years covered by this opinion.

2. <u>Adaptive Estuarine Breaching</u>

NMFS expects that adaptive management of the sand bar at the mouth of the estuary will improve habitat conditions during the spring and summer for juvenile steelhead and potentially for juvenile coho salmon, while avoiding adverse impacts to Chinook salmonids and other life history stages of steelhead and coho salmon, as described above in the RPA. However, in some conditions (high ocean swells, for example) it may not be feasible to create an outflow channel to

the north before flooding is imminent. In such cases, SCWA would need to breach the estuary in the spring or summer (May 15 to October 15)[86] as they have previously, allowing a deep channel to form roughly perpendicular to the bar. Such breaching would expose biota in the estuary to large amounts of salt water transported by tidal action. NMFS anticipates this will occur with limited frequency during the initial years of RPA implementation because SCWA will closely monitor conditions at the sandbar and maintain an adequate overflow channel. Experience gained with the alternative breaching strategies during the first few years is expected to ensure that subsequent overflow channels will work properly.

If it is necessary for the estuary to be breached in the spring or summer as it has been breached in the past, conditions are created that likely: 1) sweep small juvenile steelhead (and possibly juvenile coho salmon) out to sea before they are ready for the ocean environment, 2) increase salt levels in the estuary to amounts beyond the tolerance levels of YOY steelhead, 3) expose juvenile steelhead (and possibly juvenile coho salmon) to greater levels of predation as the freshwater lens at the top of the estuary shrinks, and 4) set up conditions for subsequent closure of the bar and temporary adverse changes to water quality as described in the biological opinion. Most of the small juvenile salmonids exposed to these conditions will die.

NMFS cannot accurately estimate the number of juvenile steelhead impacted by this type of breaching. The number may have considerable range, depending upon the timing of YOY downstream migration and when the estuary closes in the spring. Therefore, NMFS will use the number of times the estuary may be breached as a surrogate for the numbers of juvenile steelhead and coho salmon taken as described above. We estimate that SCWA 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. We assume that experience gained during years 1-3 and remediative steps associated with modification of the jetty or other flood management options will improve the proficiency of SCWA at maintaining a closed or perched lagoon. If the estuary is breached using methods that create a deep channel through the bar more than the number of times indicated above, or biological monitoring indicates periods of adverse water quality throughout the estuary longer than 3-4 weeks[87], then incidental take may be exceeded. As described in the preceding biological opinion, NMFS anticipates 3-4 weeks of adverse water quality conditions after the sandbar closes at the mouth of the estuary. A longer period of adverse water quality conditions may indicate that the formation of a closed lagoon or the creation of a perched lagoon by adaptive bar management has resulted in unanticipated water quality degradation.

Only small amounts of incidental take are anticipated for Chinook salmon migrants because, 1) these fish are anticipated to be able to enter and exit the estuary through the overflow channel that will be constructed, 2) the estuary will be fully open to ocean tides prior to the bulk of Chinook adult migration (mid-October through mid-November), and 3) most juvenile Chinook

[86] As described in the preceding biological opinion, breaching during the fall, winter, and early spring is unlikely to have adverse effects on listed salmonids.

[87] For example, dramatic reductions in invertebrate prey items, or temperatures over 23°C throughout the water column, or dissolved oxygen levels near zero throughout the water column for longer than 3-4 weeks likely indicate adverse conditions beyond those anticipated in the RPA.

salmon enter the estuary large enough to tolerate salt water. Similarly, most coho salmon in the estuary are expected to move into the ocean prior to the summer and are not likely to be adversely affected by adaptive management or a limited number of spring or summer breaching events. Those that remain are expected to leave the estuary and move upstream prior to fall breaching. As described in the biological opinion, there may be a very small number of coho salmon YOY in the estuary when it is breached. Some of these fish would likely be harmed or killed during breaching.

NMFS assumes that if partial or complete removal of the jetty in the bar at the mouth of the Russian River occurs, construction equipment will not operate in flowing water. NMFS anticipates no take of listed salmonids from jetty modification or removal. Take from using the jetty as a tool in maintaining the estuary's water surface elevation as described in the RPA is assumed to be similar to the take described above for creating the outlet at the north end of the estuary's bar.

3. Flood Control at WSD and CVD

a. WSD

In the preceding biological opinion, NMFS anticipated take of fry and juvenile stages of Chinook salmon, coho salmon, and steelhead in the first three miles of Dry Creek downstream from WSD. Changes in river stage during flood control ramping are likely to strand these species' life history stages between February and late June during the next fifteen years, exposing them to higher rates of predation. However, we anticipate that the numbers of stranded fish will be low, because of steep channel banks and lack of side channels in this area of Dry Creek.

Take of juvenile salmonids during flood control ramping at WSD is difficult to quantify for the reasons described above. NMFS has used change in river stage (estimated by the Corps (2008))[88] as a surrogate for the number of fish stranded. If flood control ramping produces a stage change greater than 1 foot per hour when releases are 3,000 cfs or less, or a stage change of greater than ½ foot per hour when ramping rates are over 3,000 cfs, anticipated take due to stranding may be exceeded.

As described in the preceding biological opinion, scour at WSD is likely to result in loss of 5-10% of salmonid redds in a three-mile reach below the dam, during years when releases are 5,000 cfs or greater. Detection of lost redds will be difficult because: 1) redds are created by salmonids in complex aquatic environments where they can be missed by observers, 2) redds can be obscured by high flow events without being destroyed, leading to incorrect counts of redds lost. Therefore, to monitor this anticipated take, NMFS will use flow release rates as a surrogate for redd loss. As described in the preceding biological opinion, NMFS estimates releases from WSD will be 5,000 cfs or greater twice during the next fifteen years (see Section VI.c.1). If releases of 5,000 cfs or greater occur more often, incidental take may be exceeded.

Small, localized loss of salmonid embryos and fry from sedimentation due to bank erosion is expected during some years. In the preceding biological opinion, NMFS determined that the

[88] Email from Chris Eng, Corps, to Eric Shott and Tom Daugherty, NMFS, February 7, 2008.

number of embryos and fry lost was likely to be small due to the limited extent of bank erosion sites. NMFS will use the frequency of WSD flow releases that are likely to produce bank erosion as a surrogate for numbers of fish taken. Bank erosion occurs when releases are 2,500 cfs or greater. NMFS estimates releases will be 2,500 cfs or greater during 8 of the next 15 years. If these releases occur with greater frequency, anticipated take may be exceeded.

b. CVD

NMFS anticipates take of juvenile steelhead and Chinook salmon due to stranding downstream of CVD in both the East Branch of the Russian River and in four miles of the Russian River mainstem downstream of the East Branch. As described in the biological opinion, stranding is more likely in the mainstem due to channel configuration. As above, the amount of fish lost is difficult to quantify. NMFS has used change in river stage as a surrogate for the number of fish stranded. If flood control ramping produces a stage change greater than 1.2 feet per hour (Corps 2008)[89], anticipated take due to stranding may be exceeded.

Scour due to flood control flow releases is expected to destroy between 3 and 13 Chinook salmon redds during eight out of the next fifteen years. Fewer steelhead redds will be lost. Due to the difficulty in observing redd loss downstream of the dam, NMFS will use the expected number of days that CVD increases the duration of scour events during the next fifteen years (as described above in the *preceding biological opinion*) as a surrogate for the number of redds lost downstream in the upper five miles of the Russian River. Our effects analysis assumes that flow releases associated with flood operations will be similar to that observed during the past fifteen years.

During the next fifteen years, NMFS anticipates years when CVD operations will extend the duration of flows over 4,200 cfs (scour events) in the upper Russian River beyond the number of days such exceedance would occur based on Russian River flows alone. Based on the analysis of these scour events in the biological opinion, NMFS anticipates that CVD will extend the duration of scour events for a total of 32 days during 16 storm events over the course of the 15 year period covered by this biological opinion. Incidental take may be exceeded if:

- CVD extends the duration of scour events by more than 32 days or during more than 16 storm events during the next fifteen years; or
- CVD in any one year extends the duration of scour events on more than 5 storms in one year; or
- CVD in any one year extends the duration of scour events by more than 14 days in one year.

Small, localized loss of salmonid embryos and fry from sedimentation due to bank erosion is expected during some years. Flows of 6,000 cfs or greater are needed to initiate bank erosion along the upper Russian River down to Hopland. Chinook salmon redds are the most likely affected given their spawning timing. There are five known bank erosion areas that continue to cause some sedimentation on an annual basis (Pat Ford, consultant for MCRRFCD, personal

[89] Email from Chris Eng, Corps to Tom Daugherty and Eric Shott, NMFS, January 31, 2008.

communication, 2008). Steelhead and Chinook redds located directly downstream of these five locations could be affected.

Similar to the issue of redd scour, it is difficult to detect redd loss from sedimentation downstream of the dam. Therefore, NMFS will use the number of days CVD is expected to extend the duration of flows greater than 6,000 cfs at Hopland (other than what would occur based on Russian River flows alone) as a surrogate for the number of redds lost downstream of CVD due to bank erosion. Based on the continuation of operations practiced during the past fifteen years, CVD releases are expected to result in an additional 31 days[90] of flow > 6,000 cfs at Hopland during the next 15 years. Therefore, incidental take may be exceeded if:

- CVD releases contribute to more than 31days of flows > 6,000 cfs at Hopland over the course of the next fifteen years, or
- CVD releases in any one year contribute to more than 16 days of flows > 6,000 cfs at Hopland; or
- CVD releases in any one year contribute to flows > 6,000 cfs at Hopland) during more than 5 storms.

This portion of anticipated take is based on ramping operations for flood control. Anticipated take from preflood/periodic inspections is described below. Changes in river stage resulting from releases from WSD or CVD in pursuit of other purposes, such as hydropower generation testing, were not analyzed by NMFS and may result in take of listed salmonids .

4. <u>Preflood/periodic inspections at CVD</u>

a. CVD

At Coyote Valley Dam, annual preflood and /periodic inspections (every five-years) are anticipated to strand no more than 20 juvenile steelhead during inspections each year.

b. WSD

NMFS does not anticipate take associated with Preflood/periodic inspections at WSD conducted in late August or September.

5. <u>Turbidity Releases from CVD</u>

Turbidity releases from CVD are anticipated to result in minor reductions in Chinook salmon and steelhead egg, alevin, fry, and juvenile survival in the upper Russian River mainstem below the confluence with the East Branch. These reductions may occur via entombment of eggs and alevins, and loss of prey for fry and juveniles due to high elevated turbidity. Information is not available to specifically quantify take that may be associated with turbidity releases from CVD nor is information available to quantify an extent of this take using a surrogate such as the

[90] Without CVD releases, flows at Hopland would likely be less than 6,000 cfs, as described in the preceding biological opinion.

magnitude or timing of the releases. In the preceding biological opinion, NMFS has assumed that the overall effect of turbidity on salmonid populations (juvenile Chinook salmon and steelhead) in the mainstem of the Russian River is low to moderate, given the relatively high production of Chinook salmon fry in the upper mainstem Russian River. Below, in the Terms and Conditions, NMFS is requiring turbidity monitoring to more precisely determine the level of impact that turbid releases from CVD have on listed salmonids.

6. Hatchery Operations

Operation of the steelhead hatchery program as mitigation for the construction and operation of CVD results in several different types of take. For example, both adult steelhead and adult Chinook salmon return to the hatchery and are subsequently captured and collected. Some of the captured adult steelhead are spawned and the remainder are transported and released into nearby streams. All of the captured adult Chinook salmon are transported and released back into the Russian River. As indicated in Section VI.E, immediate mortality of adult Chinook salmon is likely negligible; however, the collection and transport causes stress and minor injury to the adult fish. The progeny of the spawned steelhead are held in captivity for rearing, and then transported and released into streams. The types of take and numbers of steelhead affected by the hatchery program are described as follows:

1. Of the adult steelhead that are captured at the hatchery and rearing facilities each year, at least 180 female steelhead are collected and held for spawning at DCFH and at least 120 females are collected at CVFF. Up to three times as many steelhead males are also collected and spawned. Surplus adult steelhead that return to the facilities are outplanted to the Russian River watershed as described below in number 7.

2. Hatchery operations annually collect approximately 900,000 steelhead eggs at DCFH and about 600,000 eggs at the CVFF (B.Wilson, DFG, personal communication July 2008). Hatchery operations then rear (hold in captivity) about 600,000 steelhead eggs at DCFH and about 320,000 steelhead eggs at CVFF. Individuals are reared to the smolt life history stage.

3. Steelhead fry reared at CVFF are transported to DCFH where they are then reared in separate tanks from those containing progeny of adults that returned to the DCFH. Upon reaching the yearling smolt stage, the CVFF fish (approximately 40,000 pounds of fish) are then transported back to CVFF in three separate lots in late January/early February and March. Following that second transfer, they undergo 4 to 6 weeks of additional rearing, acclimation, and imprinting to home waters before they are released to the East Branch of the Russian River (as described in 5 below).

4. Before their release, all steelhead produced at both facilities are marked with an adipose fin clip.

5. Up to 300,000 DCFH steelhead smolts are transported three miles downstream from the hatchery and released into Dry Creek. During late winter and early spring, up to 200,000 CVFF steelhead smolt are allowed to volitionally leave the CVFF and swim downstream.

6. Up to 500 adult Chinook salmon can be annually trapped and relocated during the collection of adult steelhead broodstock at DCFH and CVFF, with not more than 2 percent mortality. As discussed in the **Effects of the Proposed Action** section, mortality of Chinook salmon during trapping and transport at both facilities occurs infrequently, and in most years, all Chinook salmon are trapped and relocated without mortality. The primary effects to adult Chinook salmon trapped and relocated from both facilities are non-lethal and associated with their capture, handling, and transport. The adult Chinook salmon that are trapped and relocated, should be able to successfully spawn and contribute to subsequent generations.

7. The amount of straying by returning adult hatchery steelhead is expected to be below levels (or in locations) that would cause deleterious effects on wild fish genomes and local adaptations. Competition between hatchery steelhead and wild salmonids is anticipated to be very low, because the number of strays is expected to be low. Although predation by smolt-sized hatchery fish may occur on wild salmonid fry and fingerlings, the potential magnitude of this take is low because the hatchery smolts are expected to migrate from the watershed within a few days to a few weeks and thus contact between wild fish and hatchery smolts will be limited and the release of smolts typically occurs in late winter prior to the emergence of most steelhead fry, which typically emerge between late March and late May.

Release of non-spawned adult hatchery steelhead (surplus returns to the hatchery) into the Russian River is expected to be below levels (or in locations) that would cause deleterious effects on wild fish genomes and local adaptations. Competition between hatchery steelhead and wild salmonids is anticipated to be very low, because adult hatchery steelhead are released into streams currently lacking wild steelhead. Although predation by hatchery fish may occur on wild salmonid fry and fingerlings, the potential is low, and most likely occurs (if at all) in Dry Creek, the mainstem Russian River, and within the estuary.

Adult hatchery steelhead that return to DCFH but are not needed for broodstock are released into the main stem Russian River, upstream of the confluence with Dry Creek. Adult hatchery steelhead that return to CVFF that are not needed for broodstock are relocated to the Ukiah and Cloverdale reach of the main stem Russian River, and to tributaries to the upper Russian River including: Ackerman, Feliz, Orr, Gibson, Doolan, Mill (tributary to Forsythe), Hensley, McClure, McNab, Morrison, Parsons, Howell, Dooley, McDowell, Twining, and Walker creeks.

NMFS cannot precisely estimate the amount of wild salmonids affected by competition with hatchery fish, hatchery fish predation, or disease transmission that result from straying or release of surplus fish. However, as described in the preceding opinion, the number is likely to be small. NMFS will use the average number of hatchery steelhead that returned during the last ten years, the maximum that have returned, the numbers released (by sex), and the current release sites, as a surrogate for estimating take. For example, we assume that the amount of straying is proportional to the number of returns to the hatchery. Larger numbers of steelhead returning would indicate larger amounts of straying. If returns or releases are greater than the numbers provided below, or releases occur in different streams than those described in the biological opinion, incidental take may be exceeded:

Hatchery returns average 6,700 fish for the next fifteen years, and range no higher than 12,000 fish.

Creeks where surplus adult steelhead are released (and maximum numbers of steelhead, and maximum numbers of females released) (CDFG 2008):

Stream or Location	**Maximum Number Released**	**Maximum Number of Females**
Orr Creek (below barrier only)	45	15
Gibson Creek	30	10
Doolan Creek	30	10
Mill Creek tributary to Forsythe	45	15
Hensley Creek	45	15
Mill/McClure Creeks	30	10
McNab Creek	15	5
Morrison Creek	45	15
Parsons Creek	30	10
Howell Creek	15	5
Dooley/McDowell Creeks	45	15
Walker Creek	45	15
Akerman Creek	45	15
Fleiz Creek	45	15
Twining Creek	30	10
West Fork Russian River above Mumford Dam and the Russian River near the confluence with Forsythe Creek	450	150
Ukiah Reach* and Cloverdale Reach* of the Russian River mainstem (sportfishing enhancement)	No Limit	No Limit

*Hatchery returns are used as a surrogate for incidental take for these release sites.

In subsection **C. Reasonable and Prudent Measures and Terms and Conditions** of this Incidental Take Statement, Reasonable and Prudent Measure 7, Term and Condition B.(1) requires the Corps and CDFG to incorporate wild steelhead returns to the hatchery into the spawning matrix. This will result in a small number of additional outplants of steelhead hatchery returns to the reaches of the Russian River described above. NMFS anticipates no more than 10 additional surplus adult returns will be outplanted each year.

7. Channel Maintenance Activities in Mainstem, Dry Creek, and Zone 1 A

a. Mainstem

As described above in the biological opinion, NMFS estimates that SCWA and MCRRFCD channel maintenance activities will result in the death of small numbers of juvenile steelhead relative to the number of juveniles in the mainstem each year for the next fifteen years in the Russian River mainstem. Because these losses are the indirect result of habitat degradation (loss of habitat complexity such as hiding and thermal cover) and subsequent increase in predation, the precise number of juvenile steelhead deaths will be difficult to determine. For example, direct observation of all predation events in this type of riverine environment is impossible due to limited in-water visibility. In addition, it is impracticable to monitor, all the time, everywhere juvenile steelhead may be present. Therefore, NMFS will use the location and amount of habitat disturbed every year as a surrogate for the low numbers of juvenile steelhead killed. Incidental take may be exceeded if more than 15,000 feet of mainstem Russian river channel is disturbed by maintenance activities in either Sonoma or Mendocino County over the course of the next fifteen years. No more than 2,000 feet of mainstem channel is expected to be disturbed in any given year. Incidental take may be exceeded if channel maintenance work occurs outside of the 22 mile reach between river mile 41 and 63, the 36 mile reach from the Mendocino County line north, or outside of the Mirabel and Riverfront Park Areas. Incidental take is anticipated to be low because apart from bank areas and adjacent channel bed or gravel bars disturbed by maintenance work, the surrounding channel areas will remain undisturbed. In addition, if channel maintenance activities leave habitat in a condition that is likely to result in take of other salmonid life stages, take is likely to be exceeded. For example, if migration barriers are created for any salmonid life history stage as a result of channel maintenance activities, incidental take is likely to be exceeded.

Some sites may need dewatering as described in the biological opinion. A small number of steelhead may need to be relocated from dewatered areas (<40 fish). Some steelhead may avoid relocation efforts, and the precise number of steelhead at dewatering sites will be difficult to determine. Therefore, as above, NMFS will use the total anticipated length of dewatering during the next fifteen years as a surrogate for numbers of fish. NMFS anticipates no more than 750 linear feet of the mainstem Russian River will need to be dewatered during the next fifteen years and most juvenile steelhead in these areas will be relocated successfully. No more than 3% of these fish will be injured or killed during relocation.

b. Dry Creek

NMFS estimates that channel maintenance activities in Dry Creek will result in the direct mortality or injury of small numbers of juvenile steelhead and coho salmon. The precise numbers likely killed or injured cannot be easily calculated due to the limited fish distribution and density information available, and the difficulty in observing these small aquatic organisms in the wild. NMFS has inferred small losses relative to the size of the expected juvenile population in Dry Creek due to the small area disturbed by channel maintenance activities. Therefore, NMFS will use the amount of habitat expected to be disturbed in Dry Creek during the next fifteen years as a surrogate for juvenile steelhead and coho salmon killed or injured

indirectly due to habitat destruction. A total of 600 linear feet of Dry Creek channel is likely to be disturbed each year for the next fifteen years. Incidental take may be exceeded if more than 600 feet of Dry Creek mainstem is disturbed by maintenance activities during the next fifteen years. Incidental take is anticipated to be low not only because few steelhead, and fewer coho salmon are likely to inhabit the Dry Creek mainstem in the summer, but also because apart from bank areas and adjacent channel bed disturbed by maintenance work, the surrounding channel areas will remain undisturbed. In addition, if channel maintenance activities leave habitat in a condition that is likely to result in take of other salmonid life stages, take is likely to be exceeded. For example, if migration barriers for any salmonid life history stage are created as a result of channel maintenance activities, incidental take is likely to be exceeded.

NMFS also anticipates small losses of adult Chinook salmon, steelhead, and coho salmon migrants and spawners due to loss of habitat (cover and resting pools) in Dry Creek. Although NMFS was able to estimate that roughly two Chinook and steelhead spawners may be lost each year, the chance of finding a dead or dying fish after a predation incident is extremely low. Therefore NMFS will use the amount of habitat disturbed (600 feet per year) as a surrogate for numbers of fish.

Sediment from channel maintenance activities is likely to result in the loss of not more than 2 Chinook redds per year. As above, NMFS will use the amount of habitat disturbed per year (600 feet) as a surrogate for the number of redds lost. NMFS expects that sediments from channel maintenance activities will be dispersed downstream following winter storms and will not accumulate over time near channel maintenance sites.

c. Constructed Channels - Zone 1A

Juvenile steelhead. NMFS estimates that sediment and vegetation removal activities in constructed flood control channels of Zone 1A will result in the loss of small numbers of juvenile steelhead. The precise numbers likely lost cannot be easily calculated due to the limited fish distribution and density information available, and the difficulty in observing these small aquatic organisms in the wild. As described in the preceding biological opinion, NMFS has inferred small losses due to the current poor condition of these channels to support rearing steelhead. For example, in Copeland Creek, juvenile steelhead densities ranged from 0.06 steelhead per foot to 0.01 steelhead per foot and many portions of the channel are dry in the summer.

Because the precise number of steelhead juveniles attempting to rear in these channels is unknown, NMFS will use the amount of habitat expected to be disturbed in the Laguna de Santa Rosa, Copeland Creek, Windsor Creek, and Santa Rosa Creek during the next fifteen years as a surrogate for juvenile steelhead killed or injured indirectly due to habitat destruction. NMFS expects the following lengths of these creeks to have habitat complexity (pools, instream wood, shade, etc.) degraded or destroyed during the next fifteen years at the following frequencies:

- Laguna de Santa Rosa - 2,400 feet of sediment removal three times during the next fifteen years, and 12,000 feet of vegetation removal annually;
- Copeland Creek - 3,270 feet of sediment removal six times during the next fifteen years, and 9,625 feet of vegetation removed annually;

- Windsor Creek - 500 feet of sediment removal two times during the next fifteen years, and the annual removal of 3,000 feet of vegetation during the next fifteen years;
- Santa Rosa Creek - 4,000 feet three times during the next fifteen years, and 12,100 feet of vegetation removal annually.

In addition, if flowing water is present, SCWA will relocate juvenile steelhead present in the channel lengths described above. Most juvenile steelhead are expected to be captured and relocated during channel maintenance activities. Some will remain and will be killed during dewatering. Three percent of the juvenile steelhead present are expected to be injured or killed during relocation and dewatering. As described in the biological opinion, the number of steelhead injured or killed is anticipated to be small.

Migrating salmonids. As above, NMFS is unable to calculate precise numbers of migrating salmonids (steelhead and Chinook salmon) that will be unable to migrate upstream to spawn due to channel maintenance activities in constructed flood control channels. NMFS anticipates this number will be very small based on the analysis in the preceding biological opinion. Anticipated take levels may be exceeded if the extent or frequency of channel maintenance activities are increased beyond what is described above in this incidental take statement. In addition, NMFS assumes that large trees, large woody debris, large rocks, etc. at the edges of channels will not be removed by SCWA during sediment or vegetation removal activities. Should these elements of resting and hiding cover (at higher flows) be removed, anticipated take may be exceeded. If physical barriers to salmonid migration such as concrete sills, gravel berms, or road crossings are installed in these channels during channel maintenance activities, and remain during smolt or adult migration seasons, take may be exceeded. Such barriers could further reduce salmonid migration opportunities in these channels beyond the anticipated reductions from sediment removal activities. If sediment removal at road crossings and culvert outfalls leaves depressions which trap migrating adult or juvenile steelhead as flows recede, anticipated take will be exceeded.

d. Natural Waterways Zone 1A

NMFS anticipates that fish relocation will occur once in each natural waterway in Zone 1A (excluding the Mark West Creek watershed upstream of the mouth of the Leguna de Santa Rosa) during the next fifteen years and juvenile steelhead will be relocated from no more than 50 lineal feet of channel at any one site. Three percent of juvenile steelhead are expected to be injured or killed during fish relocation activities when sediment removal work is conducted. A smaller percent (1%) are expected to avoid relocation and die during sediment removal.

In natural waterways, a small number of juvenile steelhead will likely be unable to find cover due to vegetation removal and experience higher rates of predation. It is possible that a smaller number of juvenile Chinook salmon will suffer a similar fate. Because of the difficulty in documenting salmonid loss to predators, NMFS will use the limited amount of in-channel vegetation removal as a surrogate for the anticipated take. No more than 25 percent of the in-channel vegetation will be removed at any given site, and sites are anticipated to be less than 600 feet in length. Vegetation removal is anticipated on no more than three sites per natural waterway per year. NMFS anticipates no vegetation above top-of-bank will be removed.

8. Water Diversions Including Maintenance

Inflation and deflation of the inflatable dam is likely to strand a limited number of juvenile steelhead when the dam is inflated or deflated in the late spring. NMFS anticipates no more than five juvenile steelhead will become stranded each time the inflatable dam is installed or removed. SCWA will relocate stranded steelhead, and NMFS expects it unlikely that more than 3%, or one juvenile steelhead, will be injured during each year's relocation efforts.

Similarly, very few steelhead (five or less) will be lost each year when habitat conditions are degraded by the creation of the Wohler pool. Because finding dead fish before they are eaten by predators or scavengers will be difficult in the pool environment, NMFS will base the number of fish lost each year on the size of the impoundment created, 3.2 miles. If a larger area is impounded, more juvenile steelhead may be injured or killed.

Small numbers of fry and juvenile salmonids are likely to become impinged on the fish screens at Wohler; small numbers of salmonid fry may become impinged on the fish screens at Mirabel. As described in the preceding biological opinion, NMFS cannot precisely determine the number of fish impinged, but expects this number to be modest because the flow into these diversions is a small portion of the river flow during periods of juvenile migration and likely to attract few juveniles swimming downstream. Impingement is likely to occur for the next fifteen years at Wohler, and for the next five to seven years at Mirabel, until these fish screens are replaced.

Flood flows can overtop the infiltration ponds, stranding listed salmonids in the ponds. When flood flows recede, NMFS anticipates no more than 20 juvenile Chinook salmon will need to be rescued and relocated per year at the Wohler and Mirabel infiltration ponds. Similarly, NMFS anticipates no more than 150 juvenile steelhead and one steelhead adult will need to be rescued and relocated per year. NMFS anticipates no more than 3% will be injured or killed during relocation efforts.

9. Salmonid Monitoring

a. Mainstem at Mirabel/Wohler

As part of the RPA, SCWA will monitor adult, smolt, and juvenile salmon and steelhead migrants at the Mirabel Dam site as described above in the RPA. Table 36 shows the amounts and types of take that NMFS anticipates will occur from this fish monitoring at Mirabel/Wohler.

b. Estuarine Monitoring

Under RPA element , SCWA and the Corps will adaptively manage the estuary's bar to create a brackish/freshwater lagoon environment for prolonged periods during the late spring, summer, and early fall. SCWA will monitor salmonids in the estuary (RPA section 2.4) during these time periods to evaluate the number and condition of juvenile salmonids that migrate to the estuary.

Table 37 shows the amounts and types of take that NMFS anticipates will occur from this monitoring of fish in the vicinity of the estuary.

c. Dry Creek Fish Monitoring

Under RPA element 5, SCWA will implement an annual juvenile steelhead and coho salmon rearing survey. Specific sampling protocols may include depletion-removal electrofishing, mark-recapture electrofishing, single pass electrofishing, multiple pass snorkel counts, or a two-phase approach using snorkel counts validated by habitat specific population estimates derived from electrofishing. Table 38 shows the amounts and types of take that NMFS anticipates will occur from this fish monitoring in the Dry Creek watershed.

Table 36. Anticipated annual take of listed salmonids due to fish monitoring by SCWA in the vicinity of the Mirabel/Wholer Inflatable Dam.

Species/life stage	**Take cause**	**No. of Fish**	**Take Type**	**% major injury and mortality**
Chinook salmon adults	Observe (video in fish ladders)	10,000	Observed in fish ladder	none
Chinook salmon juveniles	Capture, observe, handle, anesthetize, fin clip, release (screw trap)	30,000 (Fin clip 6,000)	Stress, minor and major injury, unintentional mortalities	3%
Steelhead adults	Observe (video in fish ladders)	10,000	Observed in fish ladder	none
Steelhead juveniles (wild or hatchery)	Observe (video in fish ladders)	2,000	Observed in fish ladder	none
Steelhead juveniles (wild)	Capture, anethetize observe, handle, fin clip, mark, tag, release (screw trap)	20,000 (fin clip or mark 2,000) (PIT tag 1000)	Stress, minor and major injury, unintentional mortalities	3%
Steelhead juveniles (hatchery)	Capture, anethetize observe, handle, fin clip, mark, tag, release (screw trap)	20,000 (fin clip 2,000) (PIT tag 500)	Stress, minor and major injury, unintentional mortalities	3%
Coho salmon adults (wild or RRCSCBP)	Observe (video in fish ladders)	1,000	Observed in fish ladder	none
Coho salmon juveniles (RRCSCBP)	Capture, anesthetize, handle, release, fin clip, mark (screw trap)	5,000 (Fin clip or mark 500)	Stress, minor and major injury, unintentional mortalities	2%

Table 37. Anticipated annual take of listed salmonids resulting from fish monitoring by SCWA in the lower Russian River and estuary downstream from Monte Rio.

Species/life stage	Take cause	No. of Fish	Take Type	% major injury and mortality
Juvenile CCC coho salmon (wild or RRCSCBP)	Capture (seine or fyke net), Anesthetize, Handle, Fin Clip, Mark, Release	2,600	Unintentional mortalities	2 percent
		Fin clip or mark		
		500 RRCSCBP		3 percent
		100 wild		
Juvenile CC Chinook salmon	Capture (seine or fyke net).	5,000	Unintentional mortalities	2 percent
	Anesthetize, Handle, Fin Clip, Mark, Release	Fin clip or mark		3 percent
		200		
Juvenile CCC steelhead (wild or hatchery)	Capture (seine or fyke net), Anesthetize, Handle, Fin Clip, Mark, PIT tag, Release	3,500	Unintentional mortalities	2 percent
		Fin clip or mark		
		2,000		
		PIT tag 1000 fish >70 mm		3 percent

Table 38. Anticipated take of listed salmonids resulting from fish monitoring by SCWA in Dry Creek.

Species/life stage	**Take cause**	**No. of Fish**	**Take Type**	**% major injury and mortality**
Juvenile CCC coho salmon (wild or RRCSCBP)	Capture(backpack electrofishing, rotary screw trap, pipe-trap or fyke-net trap), Anesthetize, Handle, Fin Clip, Mark, Release	750 RRCSCBP 500 Wild 250	Unintentional mortalities	2 percent
Juvenile CCC coho salmon (wild or RRCSCBP)	Capture (rotary screw trap, pipe-trap, or fyke-net trap), Anesthetize, Handle, Release	7,500 RRCSCBP 5,000 Wild 2,500	Unintentional mortalities	2 percent
CCC coho salmon (wild or RRCSCBP)	Observe (spawner surveys, snorkel)	75 Redds, 150 adults,	Walking in stream	none
CCC coho salmon (wild or RRCSCBP)	Carcass	150 100 RRCSCBP 50 wild	Walking in stream	none
CC Chinook juvenile salmon	Capture, Anesthetize, Handle, Fin Clip, Mark, Release	Fin Clip or Mark 3,000	Unintentional mortalities	3 percent

10. Dry Creek Habitat Enhancements

Under RPA element 3, SCWA will undertake a series of habitat enhancements in the Dry Creek watershed, including the mainstem of Dry Creek. The first enhancements will occur in several tributaries to Dry Creek within three years of issuance of this biological opinion. SCWA will choose and implement five projects from the list of ten provided in the RPA. The second enhancement effort will focus on the mainstem of Dry Creek where at least six miles of Dry Creek downstream from WSD will be enhanced to provide excellent quality summer rearing habitat for coho salmon and steelhead, and the remaining reaches of Dry Creek below WSD will be enhanced as rearing habitat through the installation of large boulder clusters. The RPA stipulates a phased schedule of construction for the Dry Creek enhancements beginning in Year 5.

The RPA directs SCWA to relocate any listed salmonids from construction sites when implementation of a particular project requires work in aquatic habitat. Due to the lack of information on salmonid densities at the project sites, NMFS cannot precisely determine the number of salmonids that will need relocation. However, based on: 1) the degraded habitat conditions in the project areas, 2) the limited extent of dewatering needed to implement these projects, and 3) the summertime work windows provided by the RPA, NMFS anticipates that only relatively small numbers of listed juvenile salmonids will need to be relocated.

Because NMFS cannot precisely determine the number of listed juvenile salmonids that will need relocation, NMFS will use the extent of work area dewatering as a surrogate for take due to capture (relocation). NMFS anticipates that no more than 200 feet of streambed will need to be dewatered for each of the five tributary enhancement projects SCWA chooses to implement within three years of the issuance of this biological opinion. In the mainstem of Dry Creek, NMFS anticipates no more than a total of 2000 feet of Dry Creek will need to be dewatered for purposes of habitat enhancement constructjon during any one year of the project. NMFS anticipates most juvenile steelhead will be captured and relocated during channel maintenance activities. Some will remain and will be killed during dewatering. Three percent of the juvenile steelhead present at the project sites are expected to be injured or killed during relocation and dewatering.

SCWA will install 20 large boulder clusters in the mainstem of Dry Creek, and in some cases, SCWA may choose stream enhancement projects in Dry Creek tributaries where LWD or boulders are dropped or hauled into aquatic habitat. Very small numbers of listed juvenile salmonids may be injured or killed during these activities if LWD or boulders are placed on top of their hiding places in streams. NMFS cannot precisely calculate the number of juvenile salmonids that may be injured or killed but expects the number will be smaller than the amount relocated from dewatered areas for other projects due to degraded aquatic habitat in the enhancement areas and corresponding sparse density of listed salmonids.

NMFS will use the number of structures provided in the RPA for each project as a surrogate for numbers of fish taken:

Crane Creek: 25 structures (LWD or boulders)
Grape Creek: 15 structures (LWD or boulders)
Wine Creek: 12 structures (LWD or boulders)
Dry Creek: 20 structures (large boulder clusters)

NMFS assumes care will be taken when LWD and boulder structures are installed. Anticipated take may be exceeded if structures are dragged more than 10 yards across or along stream beds in flowing or standing water, or if heavy equipment drives through flowing or standing water within stream banks to reach enhancement sites. Such activities may crush listed salmonids not present at the structure placement site. Similarly, digging in stream beds or stream banks with heavy equipment without relocated listed salmonids would also exceed anticipated take.

B. Effect of Take

As described above, NMFS has determined that the anticipated take for the Reasonable and Prudent Alternative is not likely to jeopardize the continued existence of CCC coho salmon, CCC steelhead, and CC Chinook salmon.

C. Reasonable and Prudent Measures and Terms and Conditions

The following RPA elements were developed by the Corps, SCWA, and NMFS and are unlikely to result in take. No RPMs are provided for these elements:

- Pursuit of lower D1610 Minimum Flows
- Project Scoping and Preliminary Design of a Water Delivery Pipeline for the Mainstem of Dry Creek

The remaining elements of the RPA may result in incidental take, including those elements that remain unchanged from the original project description. NMFS believes that the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize the likelihood of take of Central California Coast Steelhead, Central California Coast Coho Salmon, and California Coastal Chinook Salmon resulting from the Reasonable and Prudent Alternative.

In order to be exempt from the prohibitions of section 9 of the ESA, the Corps, the SCWA, and their designees must comply with the following terms and conditions, which implement the reasonable and prudent measures described below and outline necessary reporting/monitoring. These terms and conditions are nondiscretionary.

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.

<u>Purpose:</u>
Although adaptive management of the estuary's bar is anticipated to be beneficial, there are instances where adverse water quality conditions may occur if the bar must be breached as it has in the past to avoid flooding. The purpose of this RPM is to more precisely determine the extent

of low DO outflow from the Willow Creek Marsh should SCWA need to breach the bar when the estuary's surface water level is 8 feet above mean sea level or greater.

Objective:
Monitor dissolved oxygen levels in the outflow from Willow Creek Marsh and, if low DO is observed, monitor the impact of low DO outflow from the marsh on DO levels in the estuary.

Terms and Conditions:

A. If the estuary is breached when water surface elevation is 8 feet or more above mean sea level, SCWA will monitor DO levels in the lower portion of Willow Creek Marsh for 2 hours prior to breaching and for 48 hours after breaching, taking one measurement ever hour until nightfall, and resuming hourly measurements at daybreak. If DO levels are observed to decline, SCWA shall also monitor DO levels in the estuary near Willow Creek hourly for 72 hours as described above.

B. NMFS and CDFG shall be provided with a report of DO measurements and raw data within 3 months of monitoring.

RPM 2: Undertake measures to ensure that harm and mortality to listed salmonids from pre-flood/periodic maintenance at CVD are low.

Purpose:
This RPM is focused on minimizing and avoiding the stranding of juvenile steelhead during annual pre-flood and five year periodic inspections at CVD. Annual pre-flood and five-year periodic inspections require the Corps to halt flow from CVD for a period of two hours to inspect the dam conduit. During this time, the cessation of flow into the East Fork Russian River strands juvenile steelhead in the East Fork and mainstem Russian River. Currently there is no bypass capability that provides flow to the East Fork Russian River during inspections or repairs at CVD.

Objective:
Install a flow bypass system at CVD to minimize and avoid harm and mortality to juvenile steelhead during inspections and repairs at the dam.

Terms and Conditions:

A. The Corps will initiate a study within two years and complete a feasibility level report before initiating construction of a bypass system at Coyote Valley Dam by October 1, 2011. The bypass system will be completed by October 1, 2013.

B. The bypass system shall consist of the following: The Corps shall install pumps and bypass facilities (pipes, channel) to provide bypass flows of 50 cubic feet per second (cfs) into the East Fork Russian River during inspections and repairs at Coyote Valley Dam. In addition, a 15 cfs diversion to the fish hatchery should also be investigated that would provide bypass flows to the fish facility, if needed.

C. The Corps will provide NMFS with annual updates on the progress, plans, and funding of the flow bypass system.

D. During the interim years prior to the completion of the bypass system, the Corps shall implement the following measures to minimize and avoid take of listed steelhead in the East Fork and mainstem Russian River:

1. Flows from CVD will ramp up at no greater than 100 cfs/hour in order to prevent juvenile fish from being displaced from preferred habitats.

2. The Corps will have NMFS approved personnel conduct fish monitoring and relocation efforts on the day of the pre-flood inspection on the East Fork of the Russian River below Coyote Valley Dam (one mile reach) and below the East Fork and mainstem Russian River confluence downstream to the Perkins Street Bridge (three mile reach).

3. During the monitoring surveys on the East Fork Russian River and Russian River, the Corps shall document any instances of salmonid stranding, including mortalities. Any mortalities shall be identified to species, age class (length in mm), and enumerated. The date, time, location (mapped), photos, and habitat type shall be documented for all salmonid impacts.

4. A report, including all Corps activities, fish monitoring and relocation results, including fish mortalities, stream temperature and flow monitoring results shall be prepared and submitted to the following location by January 15, of each year following the pre-flood or periodic inspection:

NMFS
Santa Rosa Area Office Supervisor, Protected Resources Division
Southwest Region
National Marine Fisheries Service
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404

RPM 3: Undertake measures to ensure that harm and mortality to listed salmonids from ramping procedures at CVD are low.

Purpose:
This RPM is focused on developing the information necessary to determine if ramping procedures at Coyote Valley Dam can be modified to minimize and avoid adverse impacts to listed salmonids, and making modifications to ramping procedures, if possible. As described in the biological opinion, 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.

Objective:
Adjust ramping rates at Coyote Valley Dam if analysis of cross sectional survey information indicates stranding can be further minimized or avoided while maintaining flood control.

Terms and Conditions:

A. The Corps will complete development of the study plan within one year and provide it to NMFS for approval within a 60 day period.

B. As part of the study plan, the Corps will conduct a cross section survey, suitable for the development of a hydraulic model of the Russian River from Coyote Valley Dam to Perkins Street Bridge. The survey shall include specific gravel bars and off-channel habitats along the four-mile reach of the Russian River most susceptible to stranding impacts.

C. The Corps will complete the field survey of the Russian River from CVD to Perkins Street Bridge within two years and provide the study data and results to NMFS within 2 months of study completion.

D. As part of the study plan, the Corps will use the field data from the survey and perform a hydraulic analysis using HEC-RAS to determine the range of flows that occur when gravel bars and off-channel habitat are dewatered.

E. The Corps will use this flow range to investigate potential alternative ramp down criteria of flood control releases to try and minimize juvenile salmonid stranding at key locations, as determined in D.

F. Based on the results of the study, the Corps will adjust ramping rates at CVD to further minimize or avoid stranding within two years of study completion, if study results indicate that such adjustments will allow flood control to be maintained. The Corps will report any adjustments to NMFS prior to their implementation.

RPM4: Undertake measures to assist NMFS in determining the amount of take resulting from turbidity releases at CVD.

Purpose:
This RPM is focused on developing the information necessary to more precisely determine the impact of turbidity from CVD on salmonid growth and survival to emergence, and appropriately acting on that information. The preceding biological opinion identifies Coyote Valley Dam as a major contributor to sustained turbidity in the Russian River. The sustained level of turbidity is

expected to adversely affect the growth and survival of steelhead and Chinook salmon incubating eggs and alevins within Russian River gravels. However, the precise magnitude of impact, while expected to be low, is currently unknown. In order to better determine the magnitude of adverse effects that may result from turbidity associated with releases from Coyote Valley Dam and Warm Springs Dam, the Corps shall conduct turbidity monitoring at most of the existing stream flow gauges currently operated by the U.S. Geological Survey Water Resources Division (USGS). Based on this information, the Corps shall also develop and begin implementation of a plan to avoid and minimize these impacts.

Objectives:
Install turbidity monitoring meters at existing USGS gages, and conduct a bathymetric survey of Lake mendocino to more accurately determine the magnitude of adverse effects to salmonids caused by Corps dam releases in Dry Creek and the Russian River and develop and implement a plan to minimize incidental take.

Terms and Conditions:

A. The Corps shall conduct a bathymetric survey of Lake Mendocino to determine the level of siltation and if dredging is a reasonable alternative to reduce turbidity levels.

B. The Corps will conduct the bathymetric survey of Lake Mendocino within two years.

C. The Corps shall install turbidity meters at existing USGS gauging stations (non low-flow gages). In addition to the existing turbidity monitoring currently conducted on the mainstem *Russian River at Hopland (11462500)*, *Digger Bend* (11463980), and *Guerneville* (11467000), turbidity monitoring will be conducted at the following stream gauges:

- USGS Gauge 11461000 on mainstem Russian River (West Fork)
- USGS Gauge 11461500 East Fork Russian River above Coyote Valley Dam
- USGS Gauge 11462000 East Fork Russian River below Coyote Valley Dam
- USGS Gauge 11463000 Russian River at Cloverdale
- USGS Gauge 11465000 Dry Creek below Warm Springs Dam

D. The Corps shall contract with the USGS to have turbidity monitoring equipment installed and functioning at the sites listed above by October 1, 2009.

E. The Corps shall contract with the USGS to maintain and publish turbidity data using USGS guidelines for a period of ten years and provide annual reporting of the analysis of the data to NMFS. NMFS expects that ten years, while shorter than the project duration analyzed in the preceding biological opinion, will provide enough data on different conditions (water year types) to estimate the impact of turbidity releases from CVD.

F. The Corps shall report to the NMFS by October 1, 2009on the progress of the turbidity monitoring contracts with USGS and overall progress of the monitoring effort.

G. The Corps shall analyze the turbidity data to determine if flood control operations contribute to an increase in turbidity that adversely affect rearing and spawning habitat on the mainstem Russian River between Coyote Valley Dam and Cloverdale and monitor the turbidity that Warm Springs Dam contributes to Dry Creek.

H. The Corps shall report the results of their analysis to NMFS for review and approval. The Corps shall provide NMFS with the turbidity data and results on an annual basis. Turbidity data collected each winter and spring will be provided no later than August 15 of the same year.

I. If turbidity data confirm that adverse effects to listed salmonids are likely to occur as described in the preceding biological opinion, or indicate effects are worse than anticipated, the Corps shall provide a draft plan to minimize and avoid these effects to NMFS for review no later than July 1, 2013.

J. If turbidity from CVD or WSD is adversely affecting listed salmonids as described above, the Corps shall complete and begin implementation of a plan to minimize and avoid these adverse effects by no later than January 1, 2014.

RPM 5: Undertake measures to ensure that harm and mortality to listed salmonids resulting from Dry Creek and tributary habitat enhancements and channel maintenance activities in the mainstem Russian River, Dry Creek, and Zone 1A, are low.

Purpose:
The purpose of the following terms and conditions are to provide additional measures to reduce take of listed salmonids from direct losses due to in-channel construction and fish relocation, and indirect harm and mortality due to reduction in habitat complexity from removal of sediment, thermal cover, and hiding cover. The proposed channel maintenance and enhancement activities are likely to result in injury and mortalities to listed salmonids due to construction equipment working in flowing water in some areas, fish relocation, and, in-channel maintenance areas, reductions in hiding cover and thermal cover in some of these waters. In Zone 1A constructed channels, migration opportunities will be more limited, resulting in loss of a small number of salmonid migrants.

Objective:
Reduce harm and mortality to listed salmonids from crushing by construction equipment, relocation efforts, and loss of habitat elements important to salmonid survival.

Terms and Conditions:

A. The Corps, SCWA, or MCRRFCD shall isolate work areas located in aquatic habitat from the flowing stream and relocate listed salmonids prior to proceeding with in-channel work for flood control maintenance or habitat enhancment:

(1) The Corps, SCWA, MCRRFCD or their designees shall retain a qualified biologist with expertise in the areas of anadromous salmonid biology, including the handling, collecting, and relocating salmonids, salmonid/habitat relationships, and biological monitoring of salmonids. The Corps, SCWA, or MCRRFCD shall ensure that all biologists working on their projects are qualified to conduct fish collections in a manner that minimizes all potential risks to ESA-listed salmonids. Electrofishing, if used, shall be performed by a qualified biologist and conducted according to NMFS Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act, June 2000.

(2) The biologist shall be on site during all dewatering events to capture, handle, and safely relocate ESA-listed salmonids. The biologist shall notify NMFS biologist Tom Daugherty at 707-468-4057 or Tom.Daugherty@noaa.gov one week prior to capture activities in order to provide an opportunity for NMFS staff to observe the activities.

(3) ESA-listed fish shall be handled with extreme care and kept in water to the maximum extent possible during rescue activities. All captured fish shall be kept in cool, shaded, aerated water protected from excessive noise, jostling, or overcrowding any time they are not in the stream, and fish shall not be removed from this water except when released. To avoid predation, the biologist shall have at least two containers and segregate young-of-year fish from larger age-classes and other potential aquatic predators. Captured salmonids will be relocated, as soon as possible, to a suitable instream location in which suitable habitat conditions are present to allow for adequate survival of transported fish and fish already present.

(4) If any salmonids are found dead or injured, the biologist shall contact NMFS biologist Tom Daugherty by phone immediately at (707) 468-4057 or the NMFS Santa Rosa Area Office at TTY 866-327-8877 (enter number 707-578-8555). The purpose of the contact is to review the activities resulting in take and to determine if additional protective measures are required. All salmonid mortalities shall be retained, placed in an appropriately-sized sealable plastic bag, labeled with the date and location of collection, fork length, and be frozen as soon as possible. Frozen samples shall be retained by the biologist until specific instructions are provided by NMFS. The biologist may not transfer biological samples to anyone other than the NMFS Santa Rosa Area Office without obtaining prior written approval from the NMFS Santa Rosa Area Office, Supervisor of the Protected Resources Division. Any such transfer will be subject to such conditions as NMFS deems appropriate.

(5) The Corps, SCWA, and MCRRFCD shall allow any NMFS employee(s) or any other person(s) designated by NMFS, to accompany field personnel to visit the project site during activities described in this opinion.

B. At all channel maintenance sites in Dry Creek, the mainstem, and Zone 1A, and at all instream enhancement sites in the Dry Creek watershed: the Corps, SCWA, or MCRRFCD shall:

(1) Check construction equipment used within the creek channel each day prior to work within the creek channel (top of bank to top of bank) and, if necessary, take action to prevent fluid leaks. If leaks occur during work in the channel (top of bank to top of bank), the Corps, SCWA, MCRRFCD or their designee will contain the spill and remove the affected soils.

(2) Ensure that if coffer dams are used to isolate work areas, fill material for cofferdams will be fully confined with the use of plastic sheeting, sheetpiles, sandbags, or with other non-porous containment methods, such that sediment does not come in contact with stream flow or in direct contact with the natural streambed. All loose fill material for cofferdams shall be completely removed from the channel by October 31. Alternatively, clean gravel or clean crushed stone may be used without plastic sheeting, sandbags, etc. to separate worksites from aquatic habitat.

(3) Ensure that all pumps used to divert live stream flow, outside the dewatered work area[91], will be screened and maintained throughout the construction period to comply with NMFS' and CDFG's Fish Screening Criteria for Anadromous Salmonids. See: http://swr.ucsd.edu/ hcd/fishscrn.pdf.

(4) Ensure that coffer dams are constructed as close as practicable to the size of the work area. If coffer dams are across the channel such that they impound the channels flow, flows shall be diverted through a suitably-sized pipe from upstream of the upstream coffer dam and discharged downstream of the downstream coffer dam. Coffer dams and the stream diversion system shall remain in place and functional throughout the construction period. Normal flows shall be restored to the affected stream immediately upon completion of work at that location.

(5) Ensure that once construction is completed, all project introduced material (pipe, gravel, cofferdam, etc.) is removed, leaving the creek as it was before construction (except for the channel maintenance work). Excess materials will be disposed of at an approved disposal site.

C. For all channel maintenance and instream enhancement construction activities described in the preceding biological opinion and RPA, the Corps, SCWA, or MCRRFCD shall provide NMFS and DFG reports by February 15 of the year following construction. The report shall be submitted to NMFS Santa Rosa Area Office, Attention: Supervisor of Protected Resources Division, 777 Sonoma Avenue, Room 325, Santa Rosa, California, 95404 6528. The report will be submitted to the Regional Manager for

[91] Pumps used in the area to be dewatered must be screened as described until salmonids are relocated.

CDFG Region 3, headquartered in Yountville, CA. The report shall contain, at a minimum, the following information:

(1) Construction related activities -- The report shall include the dates construction began and was completed; a discussion of any unanticipated effects or unanticipated levels of effects on salmonids, a description of any and all measures taken to minimize those unanticipated effects and a statement as to whether or not the unanticipated effects had any affect on ESA-listed fish; the number of salmonids killed or injured during the project action; and photographs taken before, during, and after the activity from photo reference points.

(2) Fish Relocation -- If fish relocation was necessary, the report shall include a description of the location from which fish were removed and the release site including photographs; the date and time of the relocation effort; a description of the equipment and methods used to collect, hold, and transport salmonids; if an electrofisher was used for fish collection, a copy of the logbook must be included; the number of fish relocated by species; the number of fish injured or killed by species and a brief narrative of the circumstances surrounding ESA-listed fish injuries or mortalities; and a description of any problems which may have arisen during the relocation activities and a statement as to whether or not the activities had any unforeseen effects.

D. The Corps, SCWA, or MCRRFCD shall implement the following measures to reduce the impacts of channel maintenance on habitat complexity at their respective channel maintenance sites:

(1) Because the project description provided to NMFS does not provide specific work windows for Dry Creek and Natural Waterway bank stabilization, all work within the stream/riparian corridor in Dry Creek and in Natural waterways shall be confined to the period June 15 to October 15. Revegetation work is not confined to this time period.

(2) No phase of the project may be started if that phase and its associated erosion control measures cannot be completed prior to the onset of a storm event if that construction phase may cause the introduction of sediments into the stream. Seventy-two (72) hour weather forecasts from the National Weather Service shall be consulted prior to start up of any phase of the project that may result in sediment run-off to the stream.

(4) Vehicles may be driven on the dry stream/lake bed to traverse the distance to the work site from the access point and in the immediate vicinity (within 50 feet) of the work area, and only as necessary to accomplish authorized work.

(5) All exposed/disturbed areas on upper stream banks or adjacent uplands within the project site shall be stabilized. Erosion measures such as silt fences, straw hale bales, gravel or rock lined ditches, water check bars, and broadcasted straw shall be used wherever silt laden water has the potential to leave the work site.

(6) Erosion control measures shall ensure that run-off from steep, erodable upland surfaces will be diverted into stable areas with little erosion potential or contained behind erosion control structures.

(7) All new riprap shall be planted with willows or other native tree species, spaced appropriately to provide improved thermal cover for listed salmonids.

(8) No grouted riprap shall be installed at channel maintenance sites to avoid complete loss of hiding cover in riprap areas.

(9) Bioengineering techniques shall be incorporated into all bank protection projects to reduce the amount of riprap used and provide better hiding and thermal cover for listed salmonids.

(10) LWD in the mainstem shall not be disturbed unless it spans the mainstem and is causing bank erosion. LWD that spans and causes bank erosion can be cut and cabled to the banks.

(11) When grading gravel bars in the mainstem, a buffer of at least 25 feet or 10 percent of the maximum bar width, whichever is greater, shall be maintained along the edge of the low flow channel, whether vegetation is present or not.

(12) In the mainstem, gravel bar vegetation removal shall only occur outside of a 25 foot buffer zone next to the low-flow channel. On banks and levees, vegetation removal shall only occur on the upper portion of the bank outside of 25 foot buffer zone next to the channel. Vegetation within the buffers shall not be disturbed, unless it is non-native (non-native vegetation may be removed).

(13) At sediment removal sites in Zone 1(A), SCWA shall construct a low flow channel to provide enhanced migration habitat through sediment removal areas.

Sediment removal project designs will be transmitted to NMFS and CDFG 60 days prior to implementation for approval. NMFS and CDFG shall respond within 30 days with either project approval, or a list of changes needed.

The low flow channel shall be monitored at least two times in-between large storms during the winter period to assess its function as a migration corridor and impact on stream stability.

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.

Purpose:
The purpose of the following terms and conditions are to provide additional measures to reduce take of listed salmonids from direct losses due to inflation and deflation of the rubber dam at Wohler, entrapment of salmonids in water infiltration ponds, and installation of new fish screens at Mirabel. These activities are expected to result in entrapment, injury, and loss of salmonids as described above. Injury and loss due to stranding and entrapment can be minimized by rescuing

fish from areas that become dewatered or from which fish cannot escape (infiltration ponds). Adverse effects to salmonids during fish screen replacement can be minimized by isolating the work space from flowing water and relocating salmonids out of the work area. Additionally, the infiltration ponds on the east side of the Russian River can be modified or decommissioned without disrupting water supplies.

Objectives:
1) Rescue any salmonids stranded during Wohler Dam inflation and deflation, and entrapped in infiltration ponds, 2) Provide NMFS with new fish screen design at Mirabel and complete construction within 5 years of issuance of the biological opinion, and 3) Decommission or modify infiltration ponds that are no longer needed to prevent salmonid entrapment.

Terms and Conditions:

A. SCWA shall monitor the Russian River upstream and downstream of the impoundment during inflation and deflation of the rubber dam and rescue any salmonids that become stranded, relocating them to appropriate nearby riverine habitats. SCWA shall also rescue any listed salmonids that become stranded in the infiltration ponds after flood flows overtop the ponds.

(1). SCWA shall follow the protocols (1-5) for fish rescue and relocation described above in RPM 5, Term and Condition A.

B. SCWA shall complete design of the 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.

(1) During the design phase, SCWA shall work with NMFS fish passage engineers at the NMFS Santa Rosa Area Office and with CDFG engineers to ensure the design meets NMFS and CDFG specifications for avoiding impingement or stranding of listed salmonids.

(2) Within one year of the completion of the design phase, SCWA shall provide NMFS and CDFG a complete project description, including project timing, scope, and the extent of disturbance to the bed and banks of the Russian River.

(3) Upon receiving written approval from NMFS and CDFG for the design and project description, SCWA shall replace the screens at Mirabel within two years.

(4) SCWA shall isolate the workspace from flowing water and follow the protocols (1-5) for fish rescue and relocation described above in RPM 5, Term and Condition A.

C. Within three years of the issuance of this biological opinion, SCWA shall decommission or modify the infiltration ponds on the East side of the Russian River at the Mirabel/Wohler facility to prevent fish entrapment in these ponds during flood events.

(1) SCWA shall provide NMFS with a complete project description of infiltration pond decommissioning or modification within one year of the issuance of this biological opinion.

(2) The project description shall include project timing, scope, and the expected condition of the infiltration ponds and their inlets following decommissioning or modification.

(3) Upon receipt of written approval from NMFS and CDFG for the project, SCWA shall decommission or modify the east side infiltration ponds within two years.

RPM 7: The Corps (and CDFG) 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.

Purpose:
The purpose of the following terms and conditions are to implement measures to avoid adverse genetic effects to hatchery and wild steelhead from the operation of the DCFH and CVFF steelhead programs. As described in the preceding biological opinion, these programs currently exclude wild steelhead from the hatchery spawning stock. Because current information on the genetics of steelhead indicate that there are no substantial genetic differences between wild and hatchery propagated steelhead within the Russian River basin, continued exclusion of wild steelhead from hatchery spawning stock could result in a divergent hatchery population with consequent loss of genetic diversity and increase in inbreeding. To minimize the potential for adverse genetic effects, yearly genetic analysis and monitoring of spawning stock, and incorporation of wild fish into spawning stock, is needed.

Objective:
Ensure that annual genetic management occurs and in-season spawning matrixes linked to genetic monitoring are used where appropriate. Incorporate wild steelhead into the spawning stock of both programs. Obtain an HGMP under ESA 4(d) for the steelhead programs.

Terms and Conditions:

A. For the next 15 years, the Corps will conduct genetic management and genetic assessment of the DCFH and CVFF steelhead programs. Estimated annual cost for that program is $125,000.

(1) The Corps shall ensure that genetic analysis needed to develop the in-season spawning matrix for DCFH and for the annual genetic monitoring of all steelhead spawned at DCFH and CVFF is conducted in coordination with and to the standards of NMFS Southwest Fisheries Science Center. Data from the annual genetic monitoring of the steelhead program will be used to determine the need for the continuation of in-season genetic management of steelhead spawning conducted at DCFH, and will be used to determine if in-season genetic management of spawning should be implemented at the

CVFF. Estimated annual cost of the genetic management of the steelhead program is $125,000.

(2) The Corps shall ensure that CDFG is staffed to implement the in-season genetic management of steelhead spawning at DCFH. Estimated annual cost for that staffing is $50,000.

B. The Corps (and CDFG) shall operate the DCFH and CVFF programs as integrated harvest programs to minimize adverse genetic impacts associated with each program.

(1) Begin incorporating all wild steelhead that return to each facility into the spawning program annually to begin transitioning from isolated to integrated hatchery programs.

C. The Corps shall work with NMFS and CDFG to update the draft HGMP and submit the updated plan to NMFS for approval.

(1) The updated Hatchery and Genetic Management Plan shall incorporate the measures described above and other necessary measures to minimize adverse genetic effects to steelhead.
(2) The updated HGMP shall be submitted to NMFS by October 1, 2009. If the HGMP is not approved by NMFS, the Corps and CDFG shall update it to address NMFS' concerns and re-submit it for NMFS approval within one year.
(3) Once approved by NMFS, the Corps (and CDFG) shall operate the steelhead hatchery programs consistent with the approved HGMP to ensure that adverse effects to CCC steelhead associated with the steelhead hatchery programs are minimized.

RPM 8: SCWA shall undertake measures to ensure that injury and mortality to listed salmonids resulting from fish monitoring at Mirabel diversion dam, in the estuary, and in Dry Creek are low.

Purpose:
The purpose of the following terms and conditions is to reduce injury and mortalities to listed salmonids resulting from monitoring efforts at Mirabel dam, in the estuary, and in Dry Creek. Listed salmonids may be injured or killed if held in traps, nets, or out of water for too long, if handled without care, or if exposed to predatory fish in holding containers.

Objective:
Reduced injury and mortalities from capture, release, and marking related to operation of screw traps, and seining and fyke netting in the estuary.

Terms and Conditions:

A. The downstream migrant traps (rotary screw trap) shall be checked every morning of operation at a minimum. Additionally, periods of peak migration, high flows, and/or debris

levels during storm periods may require the traps to be checked more frequently to minimize associated mortality. Salmonids in the traps will be released after measurements and PIT tag implantation, as appropriate. All other fish will be released as soon as possible.

B. Fyke-net traps shall be checked at lease twice per 24 hour period (or more frequently as conditions warrant) to remove captured fish and debris. Any salmonids found in the fyke nets will be released after measurements and PIT tag implantation, as appropriate by species and life history stage. All other fish will be released as soon as possible. Photographs of the downstream migrant fyke-net trap are required and must be submitted to NMFS within 2 days of operating the trap.

C. All ESA-listed juvenile salmonids captured within the estuary/lagoon will be held in holding buckets or livewells filled with debris-free clean water and equipped with battery powered aerators before and after handling. In addition to holding buckets and livewells, ESA-listed salmonids captured within the stream are also permitted to be held in live cars, which allow water flow-through with stream ambient oxygen and temperature levels. All listed salmonids will be allowed to recover fully before being released back into the water at or close to the location from which they were taken. Water temperatures must be documented within both the sampling and fish holding areas. All precautions will be taken by the researchers to prevent overcrowding in live cars, livewells, and holding buckets and any other excessive stressing of detained fish. Fish should not be detained for more than the minimum time required to collect the necessary data.

D. ESA-listed salmonids shall be handled with extreme care and kept in water to the maximum extent possible during sampling and processing procedures. When using gear that captures a mix of species, ESA-listed salmonids shall be processed first and be released as soon as possible after being captured to minimize the duration of handling stress.

E. When using anesthesia (MS-222 or Alka-Seltzer®), extreme care shall be taken to use the minimum amount of substance necessary to immobilize juvenile ESA-listed salmonids for handling and sampling procedures. It is the responsibility of the researcher to determine when anesthesia is necessary for handling and sampling juvenile ESA-listed salmonids.

F. In the event that debris (rocks, logs, abundant vegetation, etc,) are trapped within the beach seine, researchers will remove debris before fish are centralized in the net to prevent harm. Researchers will select the smallest mesh-size seine or dip-net that is appropriate to achieve sampling objectives while reducing the probability that smaller fish will become gilled in the net.

G. ESA-listed salmonids shall not be handled if stream temperatures at the capture site exceed 70 degrees Fahrenheit. Under these conditions, fish shall only be identified and counted.

H. Fin-clips that are collected from juvenile ESA-listed salmonids, as well as any tissues that are collected from juvenile ESA-listed salmonids that are unintentionally killed

during research activities, shall be made available to NMFS upon request.

XII. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. The Corps could fund the annual collection of adult steelhead trout in tributaries of the Russian River within Mendocino County and in tributaries of Dry Creek in Sonoma County for purposes of including wild adult steelhead in the pool of steelhead spawned at CVFF and the DCFH. Inclusion of wild adult steelhead into the hatchery program would promote an integrated hatchery program which would help avoid adverse genetic affects of the mating of wild steelhead with stray hatchery fish.

2. The Corps could expand the DCFH to enable it to support a captive coho salmon broodstock program that would help recover coho salmon in watersheds near and adjacent to the Russian River (*e.g.*, Salmon Creek, Gualala River, Walker Creek, and the Garcia River).

XIII. REINITIATION NOTICE

This concludes formal consultation on the water supply, flood control, and channel maintenance operations conducted by the Corps and Sonoma County Water Agency, and Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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Enclosure 2

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

PROJECT ACTION: Water supply, flood control operations, and channel maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed.

CONSULTATION CONDUCTED BY: National Marine Fisheries Service, Southwest Region

ADMINISTRATIVE RECORD NUMBER: 151422SWR2000SR150

PUBLIC CONSULTATION TRACKING SYSTEM NUMBER: F/SWR/2006/07316

I. STATUTORY AND REGULATORY INFORMATION

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; "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 NOAA's National Marine Fisheries Service (NMFS) (as delegated by the Secretary of Commerce) 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 effect 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.

II. BACKGROUND AND CONSULTATION HISTORY

The San Francisco District of the US Army Corps of Engineers (Corps), the Sonoma County Water Agency (SCWA), and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD) have owned, maintained, or operated facilities for flood control, water supply, and hydroelectric power generation for many years in the Russian River watershed in Sonoma and Mendocino counties, California. Since December 31, 1997, NMFS, the Corps, the SCWA, and the MCRRFCD have engaged in preconsultation technical assistance to evaluate the potential risk from the Corps, SCWA, and MCRRFCD facilities and operations to species under the jurisdiction of NMFS. On May 4, 2006, the Corps submitted a letter to NMFS requesting consultation on the Corps, SCWA, and MCRRFCD facilities and operations. Please read the *Consultation History* section of the preceding biological opinion for a complete consultation history for this proposed action. A complete administrative record of this consultation is on file at the NMFS, 777 Sonoma Avenue, Room 325, Santa Rosa, California 95404.

A. Proposed Action

The Russian River Water Supply and Flood Control Project (Project) includes operation of several dams and appurtenant facilities in the Russian River watershed. Together, the facilities are operated to control flooding within the watershed, to supply water to users within and outside

the watershed, and to generate hydroelectric power. The altered flow regimes caused by the Project change the natural hydrology of the Russian River, its tributaries, and estuary. Artificial breaching of the barrier beach at the mouth of the Russian River is often required to prevent flooding of buildings adjacent to the estuary. In addition, the Project includes the operation of two fish hatchery facilities and channel maintenance activities. The duration of the Project is 15 years. Please read section III of the preceding biological opinion for a complete description of the proposed action.

B. Action Area

For purposes of this EFH consultation, the action area is the entire Russian River watershed in Sonoma and Mendocino counties, California. Most of the direct and indirect effects of the proposed project occur in: 1) the East Branch Russian River below Coyote Valley Dam and the main stem Russian River from the confluence of the East Branch Russian River to the mouth of the Russian River at Jenner (including the Russian River Estuary), 2) Dry Creek, a major Russian River tributary, downstream of Warm Springs Dam, and 3) the Laguna de Santa Rosa and its tributaries. However, some effects to EFH are expected in other portions of the Russian River watershed from interrelated activities, such as wastewater discharge.

The proposed Project occurs within EFH for various Federally-managed fish species within Pacific Salmon Fishery Management Plan (FMP), the Coastal Pelagics FMP, and the Pacific Groundfish FMP.[92] Table 1 lists the FMP-managed species 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 Project 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.

III. EFFECTS OF THE PROPOSED ACTION

[92] Definitions for Essential Fish Habitat are found at: http://www.pcouncil.org/salmon/salfmp/a14.html [for salmonids], http://swr.nmfs.noaa.gov/hcd/cpsefh.PDF [for coastal pelagic species], and http://swr.nmfs.noaa.gov/hcd/grndfsh.pdf [for groundfish species.]

Based on information from various sources, NMFS concludes that Project, as proposed, would adversely affect EFH for various Federally-managed species within the Pacific Salmon FMP, the Coastal Pelagics FMP, and the Pacific Groundfish FMP. The preceding biological opinion fully discusses NMFS' analysis of the Project and its effects on Russian River habitat. Following is a summary of the effects that NMFS believes are associated with the Project.

NMFS inferred historical estuarine habitat conditions by combining information on current conditions with scant historical information about river flow and bar closures. Given the information available, NMFS expects that prior to dams and diversions in the Russian River watershed, the estuary was likely open to the ocean for several months between late fall and early spring in nearly all years, and then closed to the ocean during the late spring through the early fall of most years. NMFS expects that the Russian River estuary likely converted to a freshwater lagoon in many years after bar closure, as seen in other California systems (Smith 1990). Conversion to a freshwater lagoon occurs following creation of a barrier beach across the mouth of the stream or river. Freshwater from upstream continues to enter the estuary and builds up on top of the salt water layer, gradually forcing the salt water layer to seep back into the ocean through the barrier beach. The estuary may also have remained stratified in some years.

Because of unnaturally high Russian River surface flow associated with the Project, the estuary surface elevation is higher than normal and can lead to flooding of low lying areas near Jenner. The SCWA breaches the barrier beach to evacuate the estuary thereby reducing surface elevation and flooding risk. The SCWA uses a bulldozer, or some other type of heavy equipment, to breach the barrier beach at the mouth of the Russian River. The breaching schedule for the Russian River system varies from year to year depending on the frequency of the creation of the barrier beach at the river mouth. Periodic breaching of the barrier beach is likely to occur from 4 to 11 times per year, based on data from past breaching events (Corps and SCWA 2004, SCWA 2002-2004, SCWA 2006-2008). Breaching can occur during any season of the year, though most frequently occur in the spring and fall. From 1996 through 2007, most breaches of the barrier beach occurred between May and November, though breaching did occur in all other months (breaching occurred in one February from 1996-2007, for example).

Conversion to a freshwater lagoon is dependent upon the date of initial closure and freshwater inflow to the estuary. Smith (1990) found that it took at least one month for a freshwater lagoon to form; however, sometimes, closed estuaries remained stratified with heavier salt water on the bottom. During the summer and fall, artificial breaching of the barrier beach on the Russian River occurs, on average, every three weeks (Corps and SCWA 2004). Water quality surveys conducted for or by the SCWA show that the Russian River estuary remains stratified following recreation of the barrier beach and conversion to a freshwater lagoon has not been observed. However, the Russian River barrier beach is probably breached too frequently to observe the conversion. When a closed estuary stratifies, lower portions of the water column (highly saline water) are not mixed and they develop very low dissolved oxygen conditions which can create adverse habitat conditions for most fish. Fish managed under the Pacific Salmon, Coastal Pelegic, and Pacific Groundfish FMPs can be subject to these harmful conditions. As noted in the biological opinion, steelhead can do well in some stratified lagoons, depending upon overall water quality and food productivity.

Additional effects to Pacific Salmon EFH occur upstream of the estuary in the main stem and tributaries of the Russian River. We have found that the amount and quality of salmonid migration, spawning and freshwater rearing habitat in the Russian River and its tributaries is degraded compared to historical conditions. The preceding biological opinion describes how Project-related water management and flood control activities have resulted in adverse changes in physical habitat (*i.e.*, depths, velocities and salinity), habitat simplification, and loss of riparian vegetation.

1. Pacific Salmon

Potential impacts to coho salmon (*Oncorhynchus kisutch*) and Chinook salmon (*O. tshawytscha*) habitat due to the proposed action have been described in the preceding biological opinion. Pink salmon (*O. gorbuscha*) are observed in the Russian River sporadically; however, that species was not included in the preceding biological opinion as that species is not listed as threatened or endangered under the Endangered Species Act of 1973, as amended. NMFS expects that pink salmon will use the estuary similarly to Chinook salmon, as adult and smolt migration times and estuarine residences times are similar between the two species (Healey 1991, Heard 1991). In summary, adverse effects of the proposed action on Pacific salmon EFH may occur from estuary breaching, water delivery activities, and flood control activities leading to decreased water quality, loss of habitat complexity, and increased turbidity. The direct result of these threats is that the function of EFH may be eliminated, diminished, or disrupted. Migration, spawning, and rearing of Pacific salmon are negatively affected by these degraded freshwater and estuarine conditions.

2. Coastal Pelagics and Pacific Groundfish

Currently the Project causes the estuary to open, through artificial breaching, at unnatural times and durations. Following breaching events, the abundance and diversity of marine and estuarine fish increases, and following recreation of the barrier beach the abundance and diversity of marine and estuarine fish decreases over time (SCWA 2005). Following the artificial breaching events of the Project, estuarine water quality becomes so poor that many fish are likely to perish. When water quality conditions degrade in the closed estuary, perhaps some highly mobile euryhaline species may be able to find refuge in some areas of the estuary, but stenohaline marine fish or poorly mobile species are likely to perish. Therefore, the Russian River estuary may become a population sink for species managed under the Coastal Pelagics or Pacific Groundfish FMP. Managing the estuary to have a historic breaching regime would reduce the number of times that species managed under the Coastal Pelagics and Pacific Groundfish FMPs are entrained into the Russian River estuary.

IV. EFH CONSERVATION RECOMMENDATIONS

As described in the above effects analysis, NMFS has determined that the proposed action would adversely affect EFH for various Federally-managed fish species within the Pacific Salmon FMP, the Coastal Pelagics FMP, and the Pacific Groundfish FMP. Therefore, pursuant to section 305(b)(4)(A) of the Magnuson-Stevens Act, NMFS offers the following EFH

conservation recommendations to avoid, minimize, mitigate, or otherwise offset the adverse effects to EFH. NMFS provides seven EFH conservation recommendations for this proposed project. These EFH recommendations are consistent with, and otherwise support, certain elements of the Reasonable and Prudent Alternative described above in section X. of the preceding biological opinion.

1) To improve conditions of Pacific Salmon, Coastal Pelagic, and Pacific Groundfish EFH, NMFS recommends that the Russian River estuary be managed to mimic natural breaching patterns. This strategy would improve rearing habitat for Pacific salmonids and would reduce the likelihood that the estuary becomes an environmental sink for species managed under the Coastal Pelagic of Pacific Groundfish FMPs. Also, to reduce the impacts to Russian River estuarine water quality, the Corps and the SCWA should consult with NMFS to develop and implement breaching protocols that reduce impacts to Pacific Salmon, Pacific Groundfish, and Coastal Pelagic EFH within the Russian River estuary.

2) The Corps and SCWA should consult with NMFS to develop and implement a study plan which seeks to better understand the potential impacts to EFH associated with the current jetty at the mouth of the Russian River estuary. At a minimum, the study plan should consider the effect the current jetty has on estuarine water current dynamics, estuary water surface elevation, water transport through the barrier beach, estuarine water quality, and sediment transport.

3) The Corps and SCWA should consult with NMFS to develop and implement a study plan which seeks to better understand the limnology of Lake Mendocino. At a minimum, the study plan should consider the effect that current operation of Coyote Valley Dam has on hydrology and sediment delivery to the East Branch Russian River, fine sediment transport dynamics through the Russian River system (including the estuary), and the effect that turbidity has on relevant water quality parameters in the East Branch and main stem Russian River (including the estuary). The study should allow for appropriate comparison with Ritter and Brown's (1971) study on the turbidity and suspended-sediment transport in the Russian River Basin.

4) The Corps, SCWA, and MCRRFCD should assess the potential to restore main stem and tributary salmonid habitat related to flood control operations. Currently aquatic and riparian habitat complexity is highly reduced in many areas impacted by Corps and SCWA flood control activities; this results in degraded Pacific Salmon EFH. By modifying current flood control practices, the Corps and SCWA can greatly improve habitat conditions, stream function, and floodplain connectivity.

5) To mitigate for any and all remaining effects to EFH, the Corps, SCWA, and MCRRFCD should work with NMFS to develop and implement restoration projects within the Russian River watershed or adjoining coastal watersheds.

V. STATUTORY RESPONSE REQUIREMENT

Please be advised that regulations at section 305(b)(4)(B) of the Magnuson-Stevens Act and 50 CFR 600.920(k) require your office to provide a written response to this letter within 30 days of its receipt and at least 10 days prior to final approval of the action. A preliminary response is acceptable if final action cannot be completed within 30 days. Your final response must include a description of measures to be required to avoid, mitigate, or offset the adverse impacts of the activity. If your response is inconsistent with our EFH conservation recommendations, you must provide an explanation of the reasons for not implementing those recommendations. The reasons must include the scientific justification for any disagreements over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects.

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