RUSSIAN RIVER BIOLOGICAL ASSESSMENT

INTERIM REPORT 8:
RUSSIAN RIVER ESTUARY MANAGEMENT PLAN

Prepared for:

U.S. ARMY CORPS OF ENGINEERS
San Francisco District
San Francisco, California

and

SONOMA COUNTY WATER AGENCY
Santa Rosa, California

Prepared by:

ENTRIX, INC.
Walnut Creek, California

January 12, 2001

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The Sonoma County Water Agency (SCWA), the U.S. Army Corps of Engineers (USACE) and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD) are undertaking a Section 7 consultation under the federal Endangered Species Act (ESA) with the National Marine Fisheries Service (NMFS) to evaluate effects of operations and maintenance activities. The Russian River watershed is designated as critical habitat for threatened stocks of coho salmon, chinook salmon and steelhead. SCWA, USACE, and MCRRFCD operate and maintain facilities and conduct activities related to flood control, channel maintenance, water diversion and storage, hydroelectric power generation, and fish production and passage.

As part of the Section 7 Consultation, USACE and SCWA will submit to NMFS a biological assessment (BA) that will provide the basis for NMFS to prepare a biological opinion (BO) that will evaluate project operations. The BA will integrate a number of interim reports on various project operations. This interim report addresses implementation of the Russian River Estuary Management Plan.

The primary action in the management of the Russian River Estuary (Estuary) is artificial breaching of the sandbar that forms across the mouth of the Estuary. Artificial breaching of the sandbar affects water quality in the Estuary. It can potentially affect adult and juvenile passage for all three protected species. An estuary provides an opportunity for juveniles to gradually become acclimated to ocean conditions before they migrate out of the river system. Given the importance of local estuaries and lagoons for juvenile steelhead and chinook rearing, it is likely that the Estuary, including the upper portions of the Estuary, provides important rearing habitat as well. Therefore, it is prudent to maintain water quality suitable to support rearing and passage in the Estuary. An artificial breach has the potential to flush juvenile salmonids out to the ocean before they are physiolgically prepared to go. Breaching of the sandbar also has the potential to increase the risk of predation by pinnipeds on listed species by concentrating salmonids in or near the breach opening. Artificial breaching may increase angling or poaching opportunities on adult fish, particulary chinook salmon.

The issues addressed in this report are summarized as follows.

1) Water Quality
2) Juvenile rearing
3) Flushing juveniles out of the Estuary prematurely
4) Adult upstream migration
5) Juvenile outmigration
6) Predation on salmonids

Artificial breaching is conducted to prevent flooding of local property, and under current augmented flow conditions, it is not possible to allow the sandbar to remain closed for an extended period of time. The breaching schedule is tied to water level at the Jenner gauge, and therefore is dependent on the amount of flow to the Estuary. Effects of augmented flows on habitat in the Estuary will be assessed in *Interim Report 3: Instream Flow Requirements*. Management alternatives for the Estuary under alternative flow regimes will be discussed in the final BA.

There is no regular pattern of sandbar closing or breaching, but under current flow conditions, the sandbar is generally breached artificially several times in the fall, although breaching may occur earlier in some years. The bar is generally open naturally in the winter and spring, and often in the early summer.

When the sandbar closes across the river's mouth, it traps salt water in a lagoon. Because salt water is denser that fresh water, it forms a layer under the fresh water from the river, forming a saltwater lens. Through natural processes, dissolved oxygen becomes depleted in the saline layer and anoxic conditions can form. The frequency of breaching and the amount of fresh water inflow are two major factors that can influence water quality in a lagoon or estuary system.

In smaller estuaries in the Central California coast, sandbar-closed conditions (lagoon) can result in excellent rearing conditions once the salt water has seeped out and freshwater conditions have developed (Smith 1990). Good water quality can also be maintained with tidal mixing or high river flows. Infrequent artificial breaching can result in poor water quality (high temperatures and low dissolved oxygen) that can stress or kill fish and can limit food availability.

Presently the Estuary is managed as an estuary (sandbar-open conditions) rather than a lagoon (sandbar-closed conditions). The plan limits bar-closed episodes to 7 to 10 days in duration. Data from water quality monitoring since 1996 suggests that artificial breaching under the Estuary Management Plan helps to limit the short-term development of poor water quality that occurs shortly after the sandbar closes (MSC 1997a, b, 1998, 2000).

In 1992 the sandbar was breached when the water level at the Jenner gauge was over 9 feet, and this resulted in a flush of anoxic water from Willow Creek into the Estuary. The height of the water behind the sandbar is generally kept below 7.0 feet at the Jenner gauge although in some instances it may be a little higher (because a long holiday weekend may delay the availabiltiy of staff). There has not been a repeat of an anoxic event during biological monitoring in the last few years. This practice is likely to reduce the risk of flushing juvenile salmonids out of the Estuary before they are ready to leave. Although water velocities in a newly created breach opening may be high, observations by SCWA staff suggest that water velocities several tens of feet inside of the Estuary are not, and the risk of flushing juveniles out is low.

Effects of artificial breaching were evaluated for juvenile rearing and for adult and smolt passage. Adult and juvenile salmonid passage requirements are 1) passage through the estuary from the ocean, and 2) good water quality when a passage opportunity exists. Artificial breaching provides more passage opportunities than would naturally occur. A key consideration is whether water quality is sufficient when those additional passage opportunities are made available. Under the current management plan, the frequency of artificial breaching limits the amount of time the sandbar is closed, and thereby limits the deterioration of water quality during juvenile rearing or juvenile and adult passage. Juvenile salmonid migration generally correlates to the occurrence of spring freshets and water quality at this time would be expected to be better than later in the summer. By limiting the time the sandbar remains closed, artificial breaching helps to minimize juvenile smolt migration delays.

Artificial breaching in the fall may produce a freshet of water that attracts early adult chinook spawners into the Estuary. Chinook salmon congregate at the mouth of the river early in the fall when water quality may be poor in the lower mainstem Russian River and there is a potential for fish to be stranded or subjected to increased stress, predation or poaching, and angling pressure. Augmented flows are likely to help reduce the potential for fish to be stranded in the lower mainstem, but problem areas have been noted (R. Coey, CDFG, pers. comm 2000). Although there have been anecdotal reports of stressed chinook in low flow, warmwater conditions in the river, these occasions have been rare (W. Cox, CDFG, pers. comm. 2000). Video monitoring at the fish ladders at SCWA's inflatable dam at Mirabel indicate that the peak spawning runs occur when the rains begin. Therefore, while some individual fish may be affected, the overall risk to the population is likely to be low. Angling pressure is not likely to be increased because although fishing is allowed in the river during the fall, the mouth of the Russian River reputedly has excellent fishing and early migrants are already subjected to angling pressure outside of the Estuary.

Artificial breaching may slightly increase the risk of predation on salmonids by pinnipeds because harbor seals tend to congegate at the sandbar when the bar is open, and because some migrating salmonids may be concentrated in or near the breach opening. A wide breach opening with ample flows minimizes the risk. Peak pinniped population periods and artificial breaching during salmonid migration periods do not overlap to a large extent, further reducing the risk to protected species. Furthermore, artificial breaching activities only occur several times in any year. Therefore, while a few fish may be affected, the risk salmonid to populations is low.

SYNTHESIS OF EFFECTS

Currently the system is managed as an estuary (bar-open conditions) rather than a lagoon (bar-closed conditions). Biological and water quality monitoring since 1996 has shown that under current flow conditions, artificial breaching of the sandbar under the Management Plan occurs frequently enough to limit poor water quality conditions from developing during rearing and passage periods. The risk to flush juvenile salmonids out of the estuary before they are ready to leave is low. Because angling pressure is high both outside of the river mouth and in the river, providing additional passage opportunities to adult salmon is not likely to increase angling pressure.

While there there may be a small increase in predation by pinneds during portions of salmonid migration periods, the risk to protected populations is low. Artificial breaching may provide adult chinook salmon an opportunity to enter the river while water quality is low, and early migrants may potentially be stressed or subject to increased predation or poaching. Although there may be a risk to a few early migrants, the risk to the population of chinook is likely to be low.

Artificial breaching activities under the Management Plan are likely to adversely affect the listed fish species because there is a low risk of increased predation on salmonids by pinnipeds if salmonids are concentrated in or near the artificial breach opening, and because early chinook salmon may have additional opportunities to migrate up the river while water conditions are poor. Because the risk is likely to be confined to only some individual fish for limited portions of salmonid migration periods, the risk to protected populations is low.

It may seem to the reader that it is contradictory to state that there is a low risk of adverse effects to protected populations, along with the statement that the proposed project is likely to adversely affect the listed species. However, the first statement is a general assessment of the risk to the larger population of the protected fish species, while the second statement reflects the possibility that one or more fish might be harmed by certain activities. These conclusions will assist NMFS with preparing a BO which may include an incidental take statement (with regard to the individual fish that may be harmed by the proposed action), as well as a determination of whether the proposed action is likely to jeopardize the continued existence of the species.

Artificial breaching activities under the Management Plan under current flow conditions are not likely to adversely affect the designated critical habitat of the listed fish species.

1.1 SECTION 7 CONSULTATION

The Sonoma County Water Agency (SCWA), the U.S. Army Corps of Engineers (USACE), and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD) are undertaking a Section 7 Consultation under the Federal Endangered Species Act (ESA) with the National Marine Fisheries Service (NMFS) to evaluate effects of operations and maintenance activities. The activities of the USACE, SCWA, and MCRRFCD span the Russian River watershed from Coyote Valley Dam and Warm Springs Dam to the estuary, as well as some tributaries. The Russian River watershed is designated as critical habitat for threatened stocks of coho salmon, chinook salmon and steelhead. The SCWA, USACE and MCRRFCD operate and maintain facilities and conduct activities related to flood control, water diversion and storage, hydroelectric power generation, and fish production and passage. The SCWA, USACE, and MCRRFCD also are participants in a number of institutional agreements related to the fulfillment of their respective responsibilities.

Federal agencies such as the USACE are required under the ESA to consult with the Secretary of Commerce to insure that their actions are not likely to jeopardize the continued existence of listed species or adversely modify or destroy critical habitat. The USACE, SCWA, and NMFS have entered into a Memorandum of Understanding (MOU) which establishes a framework for the consultation and conference required by the ESA with respect to the activities of the USACE, SCWA, and MCRRFCD that may directly or indirectly affect coho salmon, chinook salmon and steelhead in the Russian River. The MOU acknowledges the involvement of other agencies including: the California Department of Fish and Game (CDFG), the U.S. Fish and Wildlife Service (USFWS), the State Water Resources Control Board (SWRCB), the North Coast Regional Water Quality Control Board (RWQCB), the State Coastal Conservancy, and the Mendocino County Inland Water and Power Commission (MCIWPC).

1.2 SCOPE OF THE BIOLOGICAL ASSESSMENT

As part of the Section 7 Consultation, USACE and SCWA will submit to NMFS a biological assessment (BA) that provides a description of the actions subject to consultation, including the facilities, operations, maintenance and existing conservation actions. The BA will describe existing conditions including information on hydrology, water quality, habitat conditions, and fish populations. The BA will provide the basis for NMFS to prepare a biological opinion (BO) that will evaluate the project, including conservation actions.

This document presents an analysis of the potential for adverse impacts to the Russian River populations of coho salmon, steelhead, and chinook salmon as a result of certain activities. Because the ESA prohibits take of any individuals, the document will come to a conclusion of “likely to adversely affect” if any individual fish could be harmed by the proposed action, even if the overall risk of adverse impact to the overall population is low. Such a conclusion would mean that one or more listed fish might be harmed by the proposed action. Once a BA containing this determination is submitted to NMFS, formal consultation under the ESA will be initiated. During the formal consultation process, NMFS will make an assessment of whether the proposed action is likely to jeopardize the continued existence of the species. NMFS will present this conclusion in the form of a BO.

The BA will integrate a number of Interim Reports:

Report 1	Flood Control Operations
Report 2	Fish Facility Operations
Report 3	Instream Flow Requirements
Report 4	Water Supply and Diversion Facilities
Report 5	Channel Maintenance
Report 6	Restoration and Conservation Actions
Report 7	Hydroelectric Projects Operations
Report 8	Estuary Management Plan

This report evaluates the effects of implementation of recommendations of The Russian River Estuary Management Plan (Management Plan) on listed species and critical habitat in the Russian River.

1.3 STATUS OF COHO SALMON, STEELHEAD AND CHINOOK SALMON IN THE RUSSIAN RIVER

The primary biological resources of concern within the project area are coho salmon, steelhead and chinook salmon. These species are each listed as threatened under the ESA. The pertinent Federal Register notices for these species are provided in Table 1-1. Coho salmon and steelhead are native Russian River species, although there have been many plantings from other river systems (CDFG 1991). It is uncertain whether chinook salmon used the Russian River historically (NMFS 1999). They have been stocked in the past, were not stocked in the past two years, but continue to reproduce in the watershed. The Central California Coast Coho Salmon Evolutionarily Significant Unit (ESU), which contains the Russian River, extends from Punta Gorda in northern California south to and including the San Lorenzo River in central California, and includes tributaries to San Francisco Bay, excluding the Sacramento-San Joaquin River system. The Russian River is the largest drainage included in the Central California Coast Steelhead ESU, which extends from the Russian River down the coast to Soquel Creek near Santa Cruz, California. The chinook salmon listing defined the population unit that contains the Russian River as the California Coastal ESU. This ESU encompasses the region from Redwood Creek in Humboldt County to the Russian River (Sonoma County).

Critical habitat for each of these species within the Russian River is designated as the current estuarine and freshwater range of the species including “all waterways, substrate, and adjacent riparian zones.…” For each species, NMFS has specifically excluded areas above Warm Springs and Coyote Valley dams and within tribal lands.

Table 1-1 Federal Register Notices for the Salmonids of the Russian River

Species	Listing	Take Prohibitions	Critical Habitat
Coho Salmon	Vol. 61, No. 212, Pgs. 56138-56147 Oct. 31, 1996	Vol. 61, No. 212, Pgs. 56138-56147 Oct. 31, 1996	Vol. 64, No. 86, Pgs. 24049-24062 May 5, 1999
Steelhead	Vol. 62, No. 159, Pgs. 43937-43954 Aug. 18, 1997	Vol. 65, No. 132, Pgs. 42422-42481 July 10, 2000	Vol. 65, No. 32, Pgs. 7764-7787 February 16, 2000
Chinook Salmon	Vol. 64, No. 179, Pgs. 50394-50415 Sept. 16, 1999	Not yet issued	Vol. 65, No. 32, Pgs. 7764-7787 February 16, 2000

Life history descriptions for these species are provided in Sections 1.3.1 through 1.3.3 so that effects from project operations can be evaluated. All three species are anadromous, but steelhead may also exhibit a life history type that spends its entire life cycle in freshwater. These species migrate upstream from the ocean as adults and spawn in gravel substrate. Their eggs incubate for a short period, depending on water temperature, and generally hatch in the winter and spring. Juveniles spend varying amounts of time rearing in the streams and then migrate out to the ocean, completing the cycle. Details on life history, timing and habitat requirements are provided for each species.

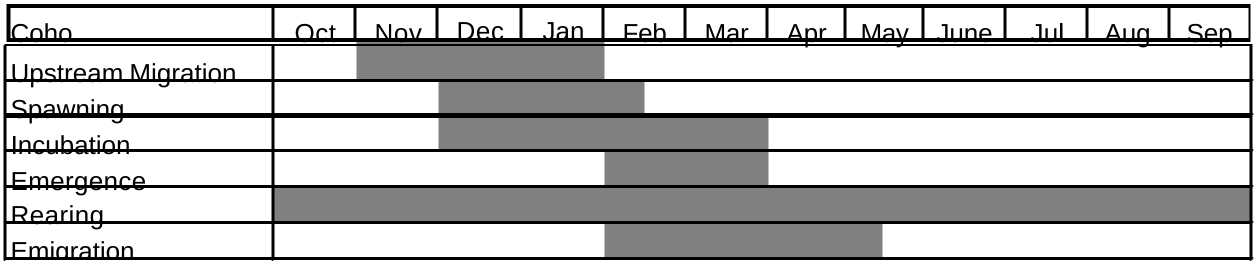
1.3.1 COHO SALMON

Coho salmon are much less abundant than steelhead in the Russian River basin. Spawning occurs in approximately 20 tributaries of the lower Russian River, including Dry Creek. In wet years, coho salmon have been seen as far upstream as Ukiah. The Don Clausen Fish Hatchery produced and released an average of about 70,000 age 1+ coho salmon each year (1980-1998). However, no coho have been produced in the last two years.

1.3.1.1 Life History

The coho salmon life history is quite rigid, with a relatively fixed three-year life cycle. The best available information suggests that life history stages occur during times outlined in Figure 1-1 (EIP Associates [EIP] 1993, SCWA 1996, SWRCB 1997, RMI 1997, S. White, SCWA, pers. comm. 1999). Most coho enter the Russian River in November and December and spawn in December and January. Spawning and rearing occur in tributaries to the lower Russian River. The most upstream tributaries with coho salmon populations include Forsythe, Mariposa, Rocky, Fisher and Corral creeks. The mainstem below Cloverdale serves primarily as a passage corridor between the ocean and the tributary habitat.

After hatching, young coho will spend about one year in freshwater before becoming smolts and migrating to the ocean. Freshwater habitat requirements for coho rearing include adequate cover, food supply, and water temperatures. Primary habitat for coho includes pools with extensive cover. Outmigration takes place in late winter and spring. Coho salmon live in the ocean for about a year and a half, return as three-year-olds to spawn, and then die. The factors



(EIP Assoc. 1993, SCWA 1996, SWRCB 1997, RMI 1997, S. White, SCWA, pers. comm. 1999).

Figure 1-1 Phenology of Coho Salmon in the Russian River Basin

most limiting to juvenile coho production are high summer water temperatures, poor summer and winter habitat quality, and predation.

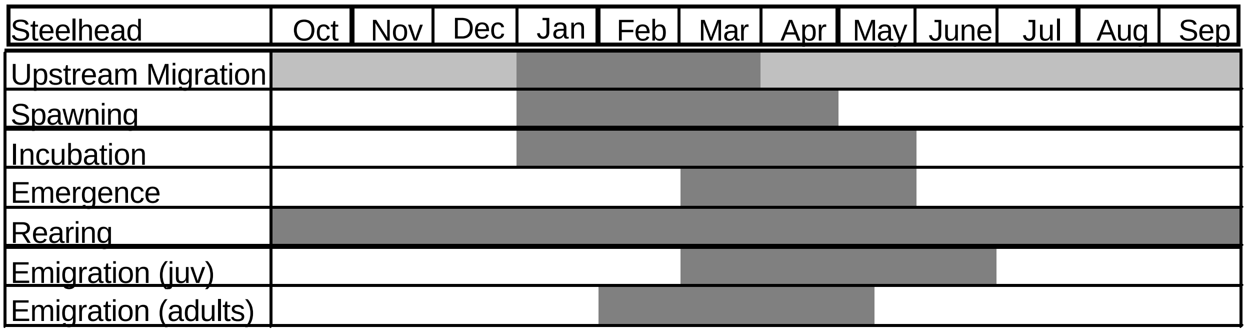
1.3.2 STEELHEAD

There have been no recent efforts to quantify steelhead populations in the Russian River, but there is general agreement that the population has declined in the last 30 years (CDFG 1984, 1991). SCWA, CDFG and NMFS are currently developing programs to monitor trends in salmonid populations within the designated critical habitat boundaries for the basin. There has been substantial planting of hatchery reared steelhead within the basin, which may have affected the genetic constitution of the remaining natural population. Almost all steelhead planted prior to 1980 were from out-of-basin stocks (Steiner 1996). Since 1982, stocking of hatchery reared steelhead has been limited to progeny of fish returning to the Don Clausen Fish Hatchery and the Coyote Valley Fish Facility.

Steelhead occupy all of the major tributaries and most of the smaller ones in the Russian River Watershed. Many of the minor tributaries may provide spawning or rearing habitat under specific hydrologic conditions. Steelhead use the lower and middle mainstem Russian River primarily for migration to and from spawning and nursery areas in the tributaries and the mainstem above Cloverdale. The majority of spawning and rearing habitat for steelhead occurs in the tributaries. However, it is possible that juvenile rearing may occur in the mainstem before smolt outmigration.

1.3.2.1 Life History

Adult steelhead generally begin returning to the Russian River in November or December, with the first heavy rains of the season, and continue to migrate upstream into March or April. Adults have been observed in the Russian River during all months (S. White, SCWA pers. comm. 1999). However, the peak migration period tends to be January through March (Figure 1-2). Flow conditions are suitable for upstream migration in most of the Russian River and larger tributaries during the majority of the spawning period in most years. Sandbars blocking the river mouth in some years may delay entry into the river. However, during the times the sand barrier is closed, the flow is probably too low and water temperature is too high to provide suitable conditions for migrating adults further up the river (CDFG 1991). Most spawning takes place from January through April, depending on the time of freshwater entry (Figure 1-2). Steelhead



Note: Peak upstream migration occurs January through March, but adults have been observed in all months. (EIP Assoc. 1993, SCWA 1996, SWRCB 1997, RMI 1997, S. White, SCWA, pers. comm. 1999).

Figure 1-2 Phenology of Steelhead in the Russian River Basin

spawn and rear in tributaries from Jenner Creek near the mouth, to upper basin streams including Forsythe, Mariposa, Rocky, Fisher and Corral creeks. Steelhead usually spawn in the tributaries, where fish ascend as high as flows allow (USACE 1982). Gravel and streamflow conditions suitable for spawning are prevalent in the Russian River mainstem and tributaries (Winzler and Kelly Consulting Engineers [Winzler and Kelly] 1978), although gravel mining and sedimentation have diminished gravel quality and quantity in many areas of the mainstem. In the lower and middle mainstem (below Cloverdale) and the lower reaches of tributaries, water temperatures exceed 55^{o}F by April in some years (Winzler and Kelly 1978), which may limit the survival of eggs and fry in these areas.

After hatching, steelhead spend from one to four years in freshwater. Fry and juvenile steelhead are extremely adaptable in their habitat selection. Requirements for steelhead rearing include adequate cover, food supply, and water temperatures. The mainstem above Cloverdale and upper reaches of the tributaries provide the most suitable habitat, as these areas generally have excellent cover, adequate food supply, and suitable water temperatures for fry and juvenile rearing. The lower sections of the tributaries provide less cover, as the streams are often wide and shallow and have little riparian vegetation, and water temperatures are often too warm to support steelhead. In the summer, these areas can dry up completely. Available cover has been reduced in much of the mainstem and many tributaries because of loss of riparian vegetation and changes in stream morphology.

Emigration usually occurs between February and June, depending on flow and water temperatures (Figure 1-2). Sufficient flow is required to cue smolt downstream migration. Excessively high water temperatures in late spring may inhibit smoltification in late migrants.

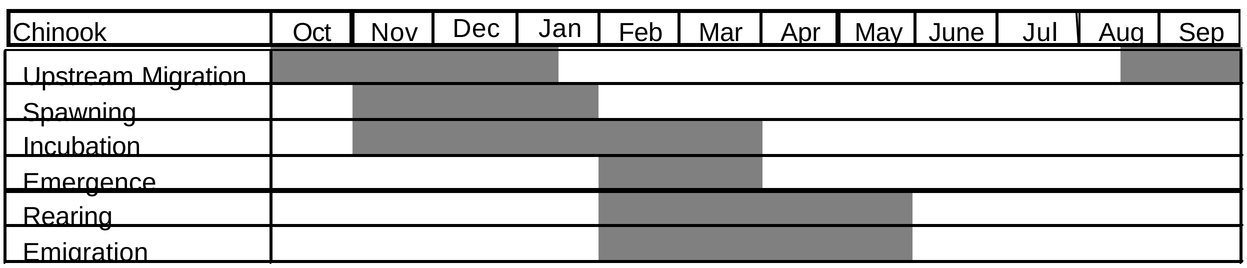
1.3.3 CHINOOK SALMON

The historic extent of naturally occurring chinook salmon in the Russian River is debated (NMFS 1999). Whether or not chinook were present historically, the total run of chinook salmon today, hatchery and natural combined, is small. Historic spawning distribution is unknown, but suitable habitat formerly existed in the upper mainstem and in low gradient tributaries. Chinook currently spawn in the mainstem and larger tributaries, including Dry Creek. Chinook tissue samples were collected this year by the SCWA, CDFG, and NMFS from the mainstem, Forsythe, Feliz, and Dry creeks, and there were anecdotal reports of chinook in the Big Sulphur system.

1.3.3.1 Life History

Adult chinook salmon begin returning to the Russian River as early as August, with most spawning occurring after Thanksgiving. Chinook may continue to enter the river and spawn into January (Figure 1-3) (S. White, SCWA, pers. comm., 1999).

Unlike steelhead and coho, the young chinook begin their outmigration soon after emerging from the gravel. Freshwater residence, including outmigration, usually ranges from two to four months, but occasionally chinook juveniles will spend one year in fresh water. Chinook move downstream from February through May (Figure 1-3). Ocean residence can be from one to seven years, but most chinook return to the Russian River as two to four-year-old adults. Like coho salmon, chinook die soon after spawning.



(EIP Assoc. 1993, SCWA 1996, SWRCB 1997, RMI 1997, S. White, SCWA, pers. comm. 1999).

Figure 1-3 Phenology of Chinook Salmon in the Russian River Basin

1.4 BACKGROUND

The Management Plan is an adaptive plan to maintain the environmental health of the Russian River Estuary (Estuary). The Management Plan has been developed from field studies that began in 1992. This section describes the events leading to the development of the Management Plan and the current approach for managing the Estuary.

The Estuary extends approximately six to seven miles from the river's mouth at the Pacific Ocean, located near Jenner, upstream to Duncans Mills and Austin Creek area, in western Sonoma County (Figure 1-4). On occasion, tidal influence has occurred as far as 10 miles upstream to Monte Rio (Russian River Estuary Interagency Task Force [RREITF] 1994).

The Estuary undergoes natural cycles in which a barrier beach (sandbar) forms across the mouth of the Estuary (closing the Estuary and forming a lagoon), and opens when hydraulic conditions in the Russian River and Pacific Ocean change. Figure 1-5 shows photographs of the Estuary open and closed.

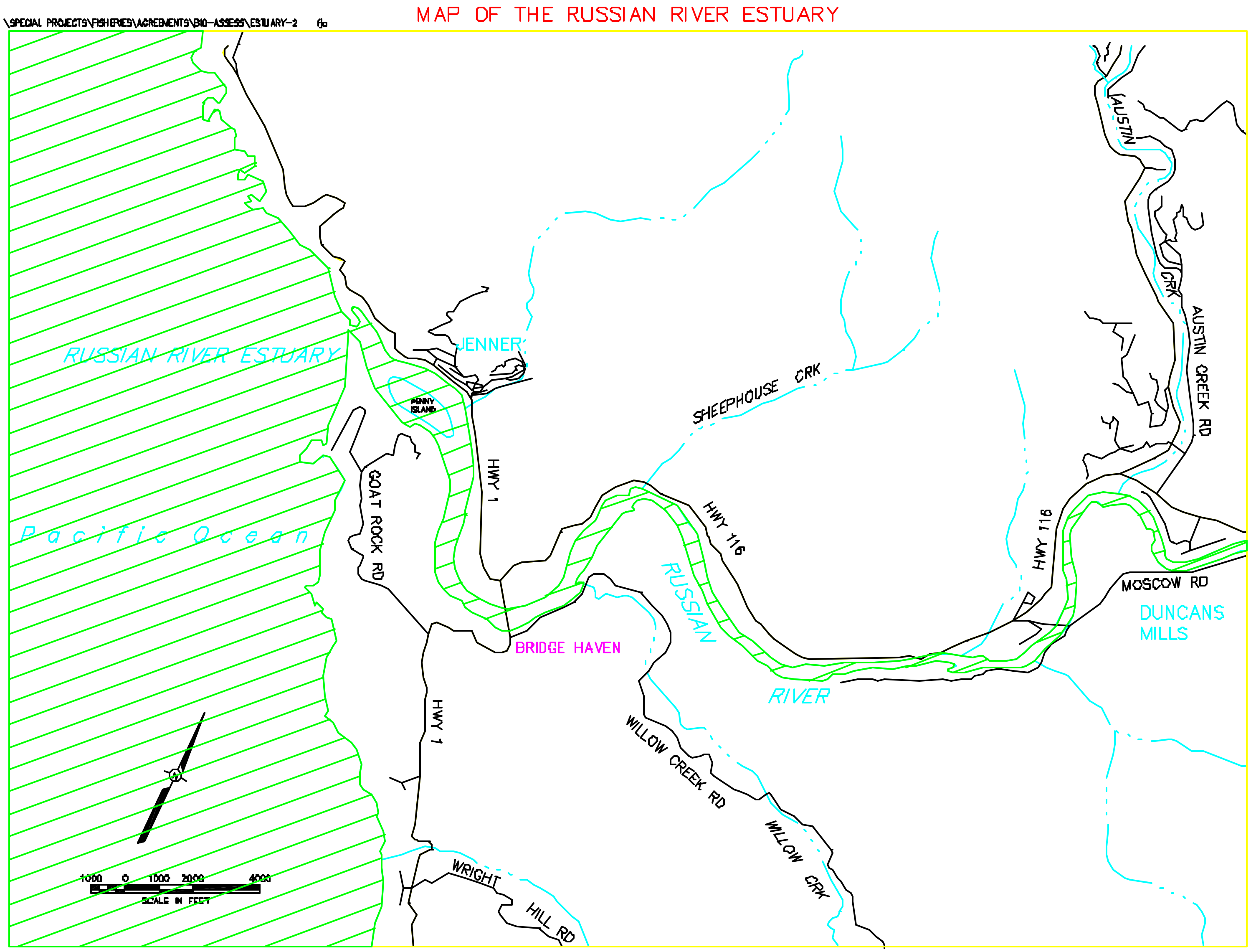


Figure 1-4 General Location Map

Estuary Open

Estuary Closed

Figure 1-5 The Russian River Estuary Open and Closed

Traditionally, Sonoma County Department of Public Works would breach (i.e., open) the sandbar at the mouth of the Russian River when it closed and caused flooding of low-lying areas surrounding the Estuary. The purpose of mechanically breaching the sandbar was to lower water levels in the Estuary and avoid flooding and property damage to adjacent lands. Within the last ten years, however, resource managers became concerned that indiscriminate breaching of the sandbar to reduce property damage may be affecting the Estuary ecosystem.

A study of the hydrological, biological, and social effects of artificially breaching the sandbar was conducted in 1992-1993 for the County of Sonoma and the California State Coastal Conservancy under the direction of the RREITF (RREITF 1994). The study selected a Preferred Alternative for managing the Estuary and recommended a detailed biological resource and water quality monitoring program be conducted during the first five years of scheduled breaching (1996-2000). The sandbar was breached artificially (by local residents and the Sonoma County Department of Public Works) before SCWA became involved. The Preferred Alternative formed the basis for the Management Plan and was adopted by the Sonoma County Board of Supervisors. Following the adoption of the Management Plan, the SCWA assumed responsibility from the Sonoma County Department of Public Works and began its implementation, including any needed revisions based on ongoing monitoring studies. Four of the five annual monitoring reports have been completed (MSC 1997, 1998, and 2000).

1.5 DESCRIPTION OF THE RUSSIAN RIVER ESTUARY

The physical setting and history of the Estuary was described in the hydrology portion of the Russian River Estuary Study 1992-1993 (RREITF 1994) and is summarized below.

1.5.1 PHYSICAL SETTING

The physical characteristics of the Russian River mouth channel opening affect tidal exchange between the Pacific Ocean and the Estuary. Whether the river mouth is open or closed is largely related to ocean conditions and to seasonal rainfall and rainfall intensity. Historical accounts indicate that the Estuary remains open during periods of low wave intensity and moderate to high freshwater river inflows. If the scouring action of the tidal flows through the channel is less than the rate of deposition of sand in the channel, due to longshore or cross-shore sand transport along the coast, the mouth of the Estuary begins to close as the sandbar extends across the channel. Closures usually occur during the spring, summer, and fall when the river inflow is low. The mouth is often open during late fall through winter, and is often closed during summer through early fall.

1.5.2 WATER QUALITY

Water temperature in the mainstem has been considered the limiting factor affecting salmonid nursery habitat quality. However, below river mile 10, coastal fog and other marine influences have a minor cooling effect on surface water. The coastal river zone may provide better summer temperature and other conditions for salmonids (Winzler and Kelly 1978).

Water quality characteristics of the Estuary can vary daily. Water quality is influenced by tidal intrusion of salt water and stratification (i.e., separating into distinct layers) of the water column in the lagoon. Water stratification is where horizontal layers within the water column are distinctly separated by such water quality characteristics as temperature, salinity, and dissolved oxygen (DO). In general, fluctuations in salinity levels in the Estuary are dampened during closures of the river mouth, while daily water temperature fluctuations increase during periods when the mouth is open. Salinity levels of approximately 30 parts per thousand (ppt) have been recorded as far as Sheephouse Creek, approximately 3.1 miles upstream from the river mouth. Salinity at this level is similar to salinities of ocean water. Typically, there is little or no salt-water intrusion into the Estuary when freshwater flows are sufficient to maintain a mouth opening. A possible exception is during periods when tides exceed six feet NGVD.

Stratification within the water column of salinity, temperature, and DO occurs in the Estuary and is most prominent in deeper pools when the river mouth is closed. In general, oxygenated freshwater occurs near the water surface and salinity levels near 30 ppt with low DO occur near the bottom. The pools often remain stratified until an influx of tidal flows or higher winter flows flush the pools or cause mixing of the stratified layers. Anoxia can develop in the bottom layers of pools under tidal conditions during neap tides and/or low river flows (MSC 2000).

Summer breaching of the sandbar draws freshwater through the Estuary and accelerates mixing of layers in the pools, which increases the DO at depth. However, flows caused by breaching may not be sufficient to mix saline waters located at the bottom of deeper pools.

1.5.3 Fish Resources

A total of 43 species of fish were collected in the Estuary during the Management Plan study (RREITF 1994 and MSC 1997, 1998, and 2000). Commonly captured estuarine/marine species include topsmelt, Pacific sanddab, starry flounder, staghorn sculpin, prickly sculpin, threespine stickleback, and shiner surf perch. The distribution of marine fish in the Estuary is limited to the lower Estuary below the Willow Creek mouth, with the most salt sensitive species found only near the Russian River mouth. Commonly captured freshwater fish include Sacramento sucker, Sacramento pikeminnow, and California roach. These species tend to move down into the Estuary and Willow Creek marsh during the summer and return upstream in the fall.

Fish species listed under the federal Endangered Species Act (ESA) occurring in the Estuary include steelhead, chinook salmon, and coho salmon. Biological sampling, which has been conducted around artifical breaching events, has been largely concentrated in fall months, and therefore is not designed to assess how salmonids may utilize the Estuary. In 1997, fish sampling occurred earlier in the summer, steelhead were captured throughout the summer, and three year classes appeared to be represented (MSC 1997). Steelhead have been captured during all years sampled. Chinook salmon have been captured in 1992, 1993, and 1997 (RREITF 1994 and MSC 1997, 1998, and 2000). Coho salmon also pass through the Estuary, but have not been captured during sampling for the Management Plan. Most adult salmonids migrate up the Russian River during the period when the mouth is naturally open, usually late fall to early spring.

Pinnipeds use the sandspit at the river mouth as a haulout and to forage for fish, including listed species, in the Estuary. Harbor seals, sometimes numbering in the hundreds, regularly use the Russian River mouth year-round, while California sea lions and elephant seals occur periodically in low numbers. Harbor seal numbers peak in the late winter and mid-summer and prefer to use the mouth when it is open.

The capture rate of salmonids by seals may be affected by the width of the breach opening and river flows during fish migration periods. A mechanical breach with a wide opening and ample flows increases access for out-migrating juveniles and returning adults through the river mouth and may reduce the potential for seals to capture salmonids. Seals have been observed foraging in the Estuary and are more successful at capturing fast-moving prey, such as salmonids, if they can take advantage of trapped or stressed fish. In 1992, out-migrating juvenile salmonids consisted of 17% of the prey items of harbor seals when the mouth was closed compared with 5% when the Estuary was open (RREITF 1994). However, this predation rate may not have been representative of typical conditions. Prior to the predation study, rainfall had increased flows in the Russian River, the sandbar and the river mouth had closed the estuary, and 36,000 salmonid smolt were released from the Don Clausen Fish Hatchery located upstream from the Estuary.

1.6 RUSSIAN RIVER ESTUARY MANAGEMENT PLAN PRACTICES

The Management Plan was developed using the Preferred Alternative presented in the Russian River Estuary Study 1992-1993 (RREITF 1994) and recommendations from the monitoring program (MSC 1997, 1998, 2000). Below are the current management practices for the Estuary:

- Breaching of the Sandbar (Barrier Beach). The sandbar is breached using a bulldozer when water levels in the Estuary are at least 4.5 feet in elevation. The SCWA's goal is to breach by 7.0 feet at the Jenner gauge. Water levels are determined from the automated tide recorder, described below. The maximum water elevation was selected to minimize the discharge of anoxic water from Willow Creek Marsh into the Estuary, to avoid high flushing velocities caused by high water elevations in the estuary prior to breaching, and to prevent the flooding of property. The breaching schedule varies from year to year depending on the frequency of closure of the Russian River mouth. In the summer of 1999, the mouth of the river closed twice in June, then remained open for the next 78 days. The sandbar was breached five times in September, October and November. Berm closures and breachings were generally concentrated in the fall in most years studied. The exception was 1997, when closures first occurred in late March. However, there is no clear pattern of closures and breachings.

- Automated Tide Recorder. An automated tide recorder has been installed at the Jenner Visitor's Center. Data from the tide recorder is displayed at the Sonoma County Water Agency's Operations Center in Santa Rosa by remote telemetry.

- Biological and Water Quality Monitoring. Biological and water quality monitoring are conducted before, during, and after four to seven mechanical breaching events per year. Monitoring is tied to breaching events, so bar-open conditions that may be maintained naturally in the early part of the summer are not monitored. Data are collected at more than four sample sites in the Estuary (Table 1-2). Water quality is also sampled at Site 3A along Willow Creek. See Figure 1-6 for the location of sample sites. At each site, fish and invertebrates are sampled with a seine and otter trawl, while water temperature, DO, and salinity are measured with water quality instruments. Pinniped behavior is monitored at the Russian River mouth by visual observations conducted by biologists.

Table 1-2 Water Quality and Fish Sampling Monitoring Locations in 1999 and 2000

Year	Water Quality	Fish Sampling
1999	Datasondes @ Stations 3, 3AA, 4	Beach seines @ Station 1, 3
	Profiles @ Stations 1, 2, 3, 3A, 3AA, 3AAA, 4	Otter trawl @ Stations 1, 2, 3, 4
2000	Datasones @ Station 3, 3A, 3AA	Beach seines @ Stations 1, 3, 4
	Profiles @ Stations 1, 2, 3, 3A, 4	Otter trawl @ Stations 1, 2, 3, 4

\SPECIAL PROJECTS\FISHERIES\AGREEMENTS\BIO-ASSESS\ESTUARY-FIG_1-6 FEB 1, 2001

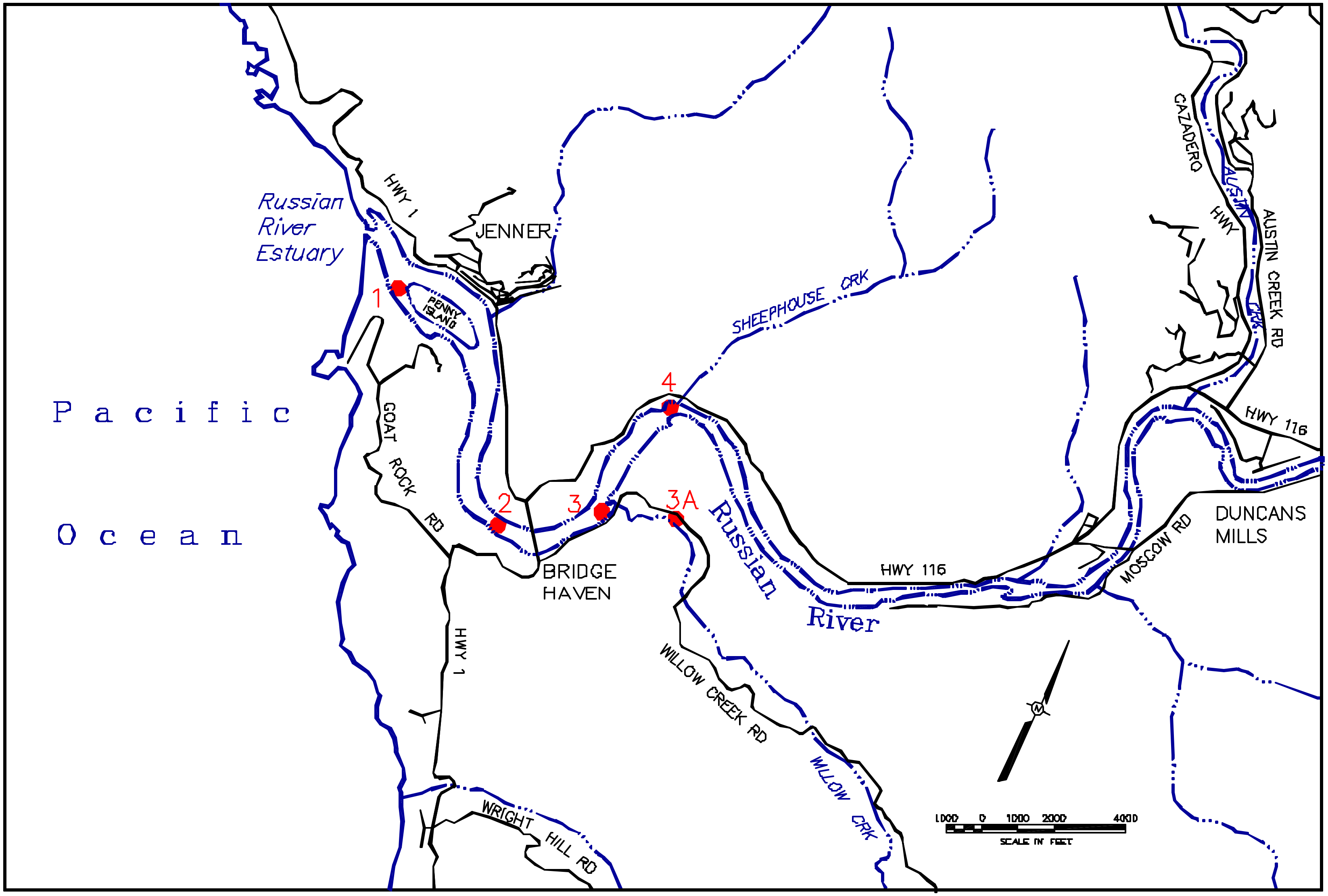


Figure 1–6 Location of Biological and Water Quality Monitoring Sample Sites

Figure 1-6 Location of Biological and Water Quality Monitoring Sample Sites

2.1 ISSUES OF CONCERN

The Russian River Estuary is part of the designated critical habitat for listed fish species. The Estuary is important for adult and juvenile passage for all three protected species. When juvenile salmonids become smolts, they undergo a physiological change that allows them to make a transition from fresh water to salt water. An estuary provides an opportunity for smolts to gradually become acclimated to ocean conditions before their migration out of the river system. Estuaries and lagoons also provide important rearing habitat for salmonids.

The primary action in the management of the Estuary is artificial breaching of a sandbar that forms naturally across the mouth of the river. When the sandbar closes, it ponds the water and forms a lagoon, and it blocks tidal flows into the river. When it is open, it forms an estuary that is open to tidal mixing. Sandbar formation is primarily influenced by offshore conditions and sand availability, and is influenced to a lesser extent by river flow (see Section 1.5.1).

Information on the historical conditions in the Estuary prior to augmented flows from Lake Sonoma, Lake Mendocino, the Potter Valley Project, and under Decision 1610, is sparse. It is likely that with reduced flows, sandbar formation occurred much earlier in the year, lasted until ocean conditons or fall rains breached the sandbar naturally, and a lagoon (sandbar-closed) existed in some or all years in the summer (R. Coey, CDFG, pers. comm 2000). Salmonids were adapted to this system, and it is likely that a productive lagoon provided excellent rearing habitat for salmonids. While there may have been sustained anoxia in some deep pools, stable conditions with better water quality could have formed in other portions of the lagoon. However, with augmented flows increasing the amount of water that flows to the Estuary in the dry season, flooding of local property has resulted in a program of artificial sandbar breaching, and the system no longer functions as a lagoon. Effects of augmented flows on salmonid habitat in the Estuary will be discussed in *Interim Report 3: Instream Flow Requirements*.

Artificial breaching affects water quality in the estuary, including salinity, temperature, dissolved oxygen, as well as instream cover and flow. This has the potential to affect migration and rearing of listed fish species. The artificial breaching program has the potential to affect adult salmonid upstream migration and juvenile downstream migration, and to affect juvenile rearing during the summer and fall. Since adult chinook salmon congregate at the mouth of the river as early as mid-August, artificial breaching is of particular concern for this species. Sandbar breaching activities also have the potential to flush juvenile salmonids out of the lower estuary before they are ready to go. Finally, breaching of the sandbar has the potential to increase the risk of predation on listed fish species. The issues addressed in this report are summarized as follows:

1) Water quality
2) Juvenile rearing
3) Flushing juveniles out of the Estuary prematurely

4) Adult upstream migration
5) Juvenile outmigration
6) Predation on salmonids.

2.2 WATER QUALITY

When the sandbar closes across the river's mouth, it traps salt water in a lagoon. Because salt water is denser than fresh water, it forms a layer under the fresh water from the river (stratification), forming a saltwater lens that traps heat. Through natural processes, dissolved oxygen becomes depleted in the saline layer and anoxic conditions can form.

This process was intensively studied in smaller central California coast lagoons in Pescadero, San Gregorio, Waddell, and Pomponio creeks (Smith 1990). The saltwater lens eventually seeps out through the sandbar if the sandbar remains closed, and the resulting freshwater conditions provide excellent rearing habitat for steelhead. The rate of conversion to a freshwater system depends on the amount of salt water impounded when the sandbar forms. It also depends on the amount of inflow to the system, which contributes to both dilution and to higher water levels that can increase the rate of seepage through the sandbar. If the sandbar is breached, salt water flows in again and then when the sandbar reforms, salinity stratification occurs and the cycle of freshening must begin anew. Flows in these central California coastal creeks are not augmented, and if a sandbar is breached during low flows in the summer, the rate of conversion to a fresh water system can be very slow, and may not even occur again in that season. This condition results in a return to poor water quality.

If one of these central California estuaries (sandbar-open conditions) remains open, good water quality can be maintained with tidal mixing or high river flows (Smith 1990). In a lagoon (sandbar-closed), good water quality develops when the system is converted to freshwater, which results in lower water temperatures and higher bottom dissolved oxygen levels. Infrequent breaching of these lagoons, especially during low-flow summer months, impairs water quality because salinity stratification results in higher water temperatures and low dissolved oxygen levels (Smith 1990).

Because the Russian River Estuary is not currently mangaged to allow a lagoon to form, the monitoring program can not address what water quality would be like if extended lagoon conditions were allowed to develop. Potential water quality problems could exist under such a scenario. In November of 1992, anoxic water from Willow Creek was flushed into the Estuary when the sandbar was breached at a water level over 9 feet. Furthermore, nutrient levels in the Estuary are increased by agricultural runoff and treated sewage discharge. However, augmented summer flows under Decision 1610 are much higher than they would naturally be, and unlike the estuarine systems studied by Smith (1990), the Estuary has substantial flow throughout the summer which could help to maintain suitable water quality conditions. It is likely that with augmented flows under sandbar closed conditions, the lagoon would increase in size until some sort of equilibrium is reached, when outflow through the sandbar equals inflow from the river. While deep pools with salt water in the bottom layers may remain, it is likely that in this lagoon there would be more surface area and more shallow water habitat with better water quality, and possibly increased productivity, than currently exists during sandbar open conditions (R. Coey, CDFG, 2000). However, flooding of local property under augmented flows precludes the management option of not breaching the sandbar under current flow conditions because too much water flows to the Estuary. While not breaching the sandbar may be a biological option, it does not appear to be a social option.

Effects of alternative flow regimes will be considered in the final BA.

2.2.1 EVALUATION CRITERIA FOR WATER QUALITY

In 1992, a fish and invertebtrate kill was associated with a flush of anoxic water from Willow Creek after the sandbar was breached when water levels were over nine feet (RREITF 1994). At high water levels, larger areas of the marsh in Willow Creek are inundated, and a larger water volume may have become anoxic. This kind of event has not occurred during four years of monitoring in the estuary (MSC 2000). Mortality of prickly sculpin in 1998, associated with a breaching event after water levels rose to 8.2 feet, may have been caused by low DO in water draining from Willow Creek, but no anoxia was detected (MSC 1999). Dead dungeness crabs were found in 1999 near the mouth of Willow Creek, but this was most likely due to a flush of fresh water after an artificial breaching event (MSC 2000). Artificial breaching of the sandbar is currently conducted at lower water elevations on the Jenner gauge. Breaching below approximately 7 feet at Jenner appears to prevent the outflow of anoxic water from the creek.

Under current flow conditions, with the mouth of the Russian River breached to prevent flooding of local property, the system is essentially managed as an estuary rather than a lagoon. With the current level of artificial breaching effort, the bar-closed times are generally limited to 7 to 10 days (MSC 2000). The first four years of a five year monitoring study collected water quality data before, during and after artificial breaching events in sites between near the River's mouth to Sheephouse Creek. Additionally, datasondes (instruments used to record hourly temperature, salinity and DO a few centimeters above the river bottom) were employed in deep pools at stations in the Estuary and in Willow Creek throughout the study season (Figure 1-6). In the summer of 1999, the sandbar closed twice in June, but then remained open for the next 78 days. The bar was breached five times in September, October and November. This pattern of sandbar closure and breachings concentrated in the fall was similar to other years studied except 1997, when closures first occurred in late March. Therefore, data from breaching surveys have been concentrated in the fall.

Water quality is affected by the schedule of artificial breaching, but is not completely determined by it. Water quality monitoring in the Russian River Estuary found that the renewal of DO in the saline near-bottom layers of deep pools is mediated by both river flow and tidal action (spring/neap cycle) as well as by post-breaching flushing (MSC 2000). While low DO in the near-bottom layers of the deep pools is associated with sandbar-closed conditions, anoxia can also develop under tidal conditions during neap tides and/or low river flows.

When the sandbar closes, salinity stratification leads to changes in dissolved oxygen and temperature in the near-bottom layers of deep pools that contribute to deterioration in water quality in those layers within the first two weeks. Freshwater surface layers often provide better DO concentrations, but surface water temperatures may still be high during the summer months. When the sandbar is breached, tidal mixing can contribute to a renewal of dissolved oxygen and reduced temperatures. This process occurs most quickly near the mouth of the river, but may take several days at upstream sites. The rate of change is influenced by the volume of river flows, whether there is a spring tide or neap tide, and the length of time the sandbar remains open. When the sandbar reforms, salinity stratification again leads to a deterioration of water quality in deep pools.

Some datasonde water quality data collected in 1999 illustrates that when the Estuary remains open, water quality is generally higher in the near-bottom layers. It should be noted that datasonde monitoring may give a general assessment of water quality changes in these deep pools, but does not assess the extent of microhabitat elsewhere that may provide refuge. Table 2-1 provides a summary of sandbar closures and breaching for 1999.

Table 2-1 Summary of 1999 Sandbar Closures and Breachings

Date Closed	Days Closed	Date Breached	Gauge Height[1]	Days Open
June 12[2]	3	June 15	7.4	6
June 24	6	July 1	6.3	78
September 17	7	September 23	6.6	2
September 25	8	October 4	7.0	3
October 7	14	October 15, 21[3]	6.7, 7.4[3]	9
November 1	3	November 4[4]	5.7	2
November 6	4	November 10	8.9	3

[1]Height on tide gauge immediately before breaching.
[2]Sandbar closed completely on June 12, but was partially closed for at least 9 days before that.
[3]Sandbar was breached October 15 but closed again the following day. Sandbar was breached again on October 21.
[4]Sandbar evidently breached itself.

The sandbar closed twice in June, but remained open from July to mid-September. At Station 3 at the mouth of Willow Creek, temperatures in the near-bottom layer of the monitored pool were good when the sandbar was open, and DO levels fluctuated, generally increasing during spring tides and decreasing during neap tides (Figure 2-1) (MSC 2000). After the sandbar closed on October 7, 1999, dissolved oxygen decreased steadily from between 6 and 7 parts per million (ppm) during a 14-day closure, until anoxia was reestablished in the bottom layers of the pool by October 18 (11 days later). During two brief November closures (3 and 4 days long), dissolved oxygen levels declined, from approximately 5 ppm to very low levels, but anoxic conditions did not form in the near-bottom layer. On November 7, it rained.

In contrast, at Station 4, the most upstream monitoring site, near bottom anoxia was not relieved until five days after a June 15 breaching (Figure 2-2). This occurred during neap tides at a river flow of 260 cfs. When the sandbar closed on June 24, near-bottom dissolved oxygen gradually declined during a 6 day closure, and contintued to decline for several days after the July 1 breaching. Highest dissolved oxygen values were usually associated with spring tides (MSC 2000). Additional data are available in reports from four years of monitoring. (MSC 1997a, b, 1998, 2000).

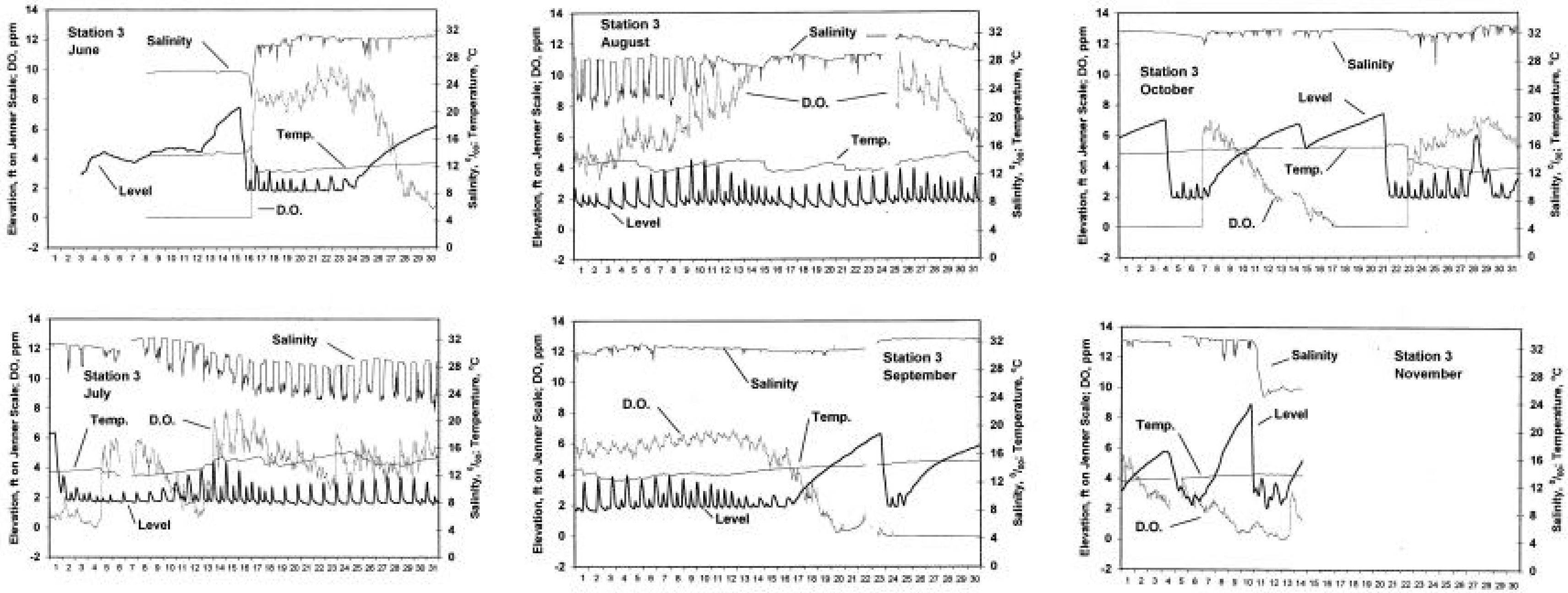


Figure 2-1 Datasonde Water Quality Data at Station 3 in 1999 (bottom layer of a pool)

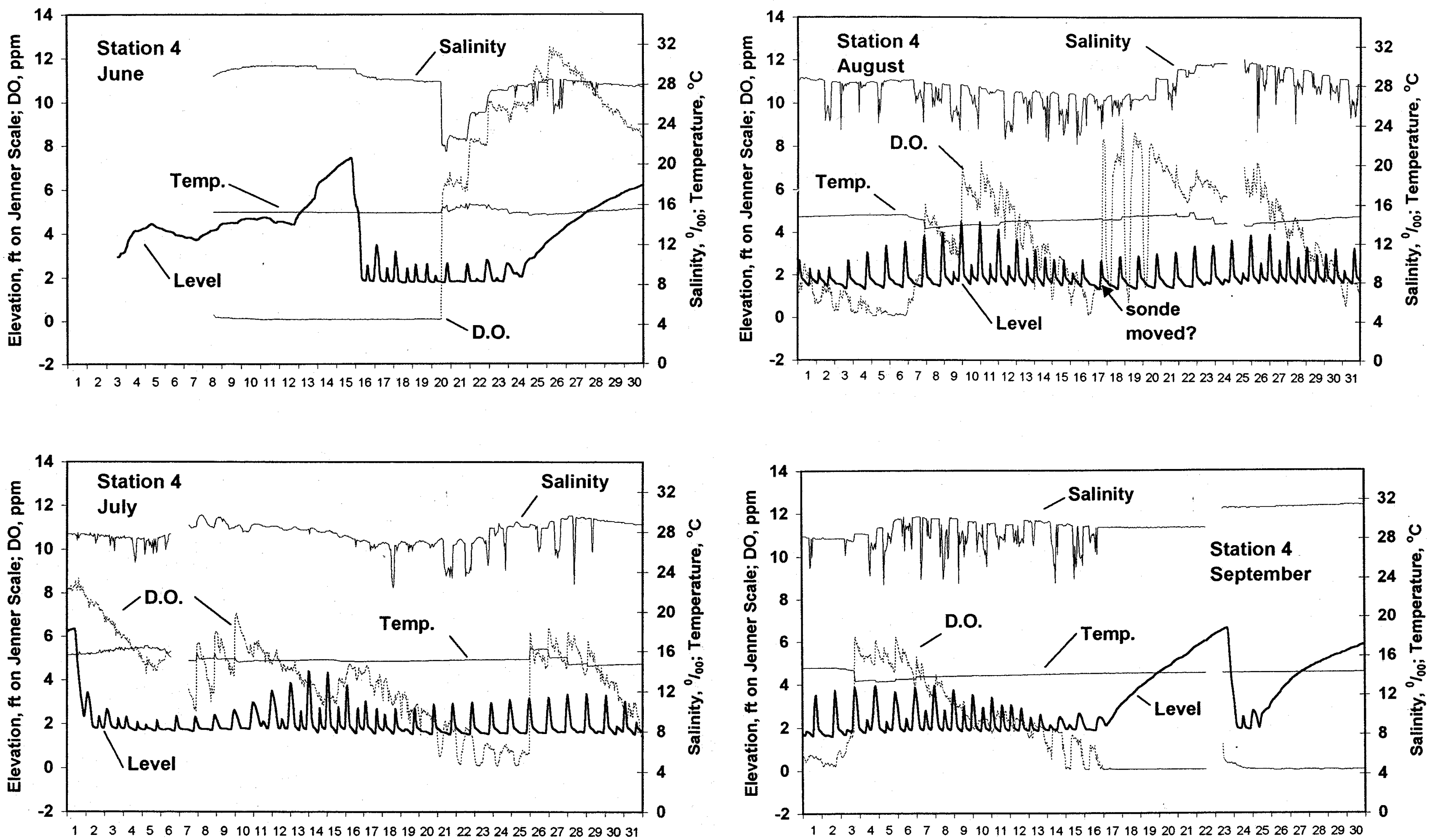


Figure 2-2 Datasonde Water Quality Data at Station 4 in 1999 (bottom layer of a pool)

Water quality profiles (observed at 1 meter vertical intervals) in the deepest part of the channel at each station were taken before, during and after breaching events. At relatively high river flows (averaging 400 cfs in the first week of June, 1999), and sandbar open conditions, all four stations had stratified conditions. Near bottom DO depletion generally occurred during bar-closed conditions, but did sometimes occur when the bar was open. Water quality profiles were generally taken in the afternoon. Variation in temperature and DO were observed between surface and bottom layers, and diurnal variation is likely to have occurred. During prebraching surveys, surface temperatures could sometimes become quite high, but bottom layers, with low DO, were cooler. Intermediate layers often provided intermediate temperatures and DO levels. For example, in a prebreaching survey on June 30, 1999 at Station 2, surface waters were approximately 24°C, but in subsurface layer with a very high DO spike (probably related to photosynthetic plants) water temperatures were between 15 and 20°C. A survey on July 6 during tidal conditions had a similar temperature and salinity profile, but DO was more uniform from surface to bottom at levels between approximately 6 and 8 mg/l.

Water quality in near-bottom layets of pools appeared to be better when the sandbar was open than when it has been closed for a couple of weeks. Given the general decline in dissolved oxygen levels (and increases in water temperature), particularly in near-bottom layers of deep pools, during bar-closed episodes, it appears prudent to limit the duration of bar-closed episodes. The sandbar is breached more frequently under the Management Plan than it was previously, and this may help to reduce low dissolved oxygen and high temperatures in the estuary. Therefore, evaluation criteria were developed based on the frequency of breaching. (These criteria only apply if the system is managed as an estuary; mangement of the system as a lagoon would require substantially different criteria.) The highest score is given to a breaching schedule that keeps the sandbar closed for only several days (Table 2-2). Longer periods of time are given lower scores. Sandbar closed episodes during the monitoring study did occasionally exceed 10 days, and we estimate that in general, closure of the sandbar for longer than 14 days may result in water quality conditions that are detrimental for salmonids.

Table 2-2 Water Quality Evaluation Criteria under Estuary Managment

Category Score	Frequency of Artificial Breaching (time sandbar remains closed)
5	0-5 days
4	6-10 days
3	11-14 days
2	15-21 days
1	> 22 days

The frequency of artficial breaching is currently tied to the water level at the Jenner gauge rather than to the time the sandbar remains closed. The primary consideration was to prevent an inflow of anoxic water from Willow Creek. However, given a decline in water quality that is likely to occur over the short-term when the sandbar closes, evaluation criteria are based on the amount of time the sandbar remains closed. (Water quality is also partially influenced by inflow from the river and by the strength of the tides.) The rise in water level at the gauge is likely be the slowest during the late summer/early fall, particularly in critically dry years when flows are lowest, and therefore under the current management plan, the sandbar may remain closed longer than during higher spring flows. However, most of the artificial breaching events studied during the monitoring effort occurred during this time, and water quality monitoring data suggests that the practice of breaching the sandbar based on water level at the Jenner gauge has resulted in a schedule of breaching that can help to limit degradation of water quality.

2.3 JUVENILE REARING

Estuaries and lagoons provide important rearing habitat for salmonids. Smaller lagoons in the southern portion of the Central California Coast Steelhead ESU have been shown to provide important rearing habitat for steelhead in the summer (Smith 1990), as well as smaller lagoons north of the Russian River (Larson 1987, Anderson 1995, 1998, 1999, S. Cannatta, CDFG, pers. comm 2000). In smaller, Central California coast lagoons, it has been shown that food rich estuaries/lagoons are very important for steelhead rearing, and even small systems can contribute substantially to juvenile growth, which in turn can translate into increased return rates for adults (Smith 1990). Lower river environments in the north (most of which are estuaries open to tidal mixing) also provide important habitat for chinook fry or fingerling rearing (Reimers 1973, Healey 1979, Levy and Northcote 1982, Kjelson, *et. al* 1982, Simenstad 1982, Anderson and Brown 1982, Meyers and Horton 1982, Groot and Margolis 1991). The classic Reimers (1973) study demonstrated that chinook salmon exibiting a life history strategy that remained in fresh water until early summer, then reared for a period of improved growth in the estuary, represented about 90% of the returning spawners in the Sixes River, Oregon. In the Sacramento-San Joaquin River estuary, chinook fry rear in freshwater habitat in the upper delta, then move into brackish water when they become smolts (Kjelson, *et. al*, 1982). Coho salmon are not thought to use the estuary for rearing (either historically or at present) because the available body of evidence for the species indicates that most rearing takes place in the riverine pool and run habitats that are typified by tributary stream reaches (Groot and Margolis 1991).

The Russian River Estuary differs in some respects to estuaries and lagoons that have been studied elsewhere. In general, rearing conditions have not been well characterized for lagoons or estuaries of this size. There does not appear to be significant juvenile rearing in the estuary/lagoon systems in the Santa Ynez and Salinas rivers, which are similar in size to the Russian River. However, this is probably because high summer water temperatures, or in the case of the Salinas River, difficult migration conditions in the lower river in some years, limit steelhead numbers (MCWRA 1998, SYRTAC 1997), and therefore comparison to these more southern rivers may not be appropriate. Rivers in the Pacific Northwest experience different rainfall patterns and climate, and therefore may not always provide useful comparisons. While they are smaller than the Russian River Estuary, local estuarine systems that have been studied, including ones in the Central California Coast Steelhead ESU (Smith 1990), Redwood Creek in Humboldt County (Anderson 1995, 1998, 1999, Larson 1987), or the Navarro River (S. Cannata, CDFG pers. comm 2000), may provide a more accurate assessment of the potential importance for the Russian River's estuarine system for juvenile rearing. A major difference of these systems from the Russian River is that they do not have augmented flows in the summer.

Redwood Creek has a small estuarine system that has been significantly modified by flood control levee construction, and this has eliminated or degraded much of the estuary as rearing habitat (Anderson 1995, Larson 1987). Even so, the lagoon is important for steelhead and chinook rearing. Anderson and Brown (1982) found that juvenile chinook do not spend a majority of rearing time in tributary or mainstem habitat, confirming the importance of the Redwood Creek estuary for rearing. McKeon (1985) determined that in Redwood Creek, estuary reared juvenile chinook grew to a larger size than river reared fish, and this is likely to improve ocean survival and return. While most coho captured in recent years have been migrating smolts, coho may have utilzed the south slough as rearing habitat at one time (Anderson 1995). Larson (1987) documented an uncontrolled breach by local landowners in July 1980 that exposed rearing fish to an abrupt transition from fresh to salt water, flushed juveniles to the ocean, eliminated most of the rearing habitat in the lagoon, and probably reduced ocean survival of these fish. Controlled breaching of the sandbar is currently conducted to avoid flooding of local property while minimizing the risk of flushing juveniles out prematurely. Controlled breaching keeps water levels in the lagoon higher than they would be with uncontrolled breaching, to help maintain as much rearing habitat in the lagoon as possible under current conditions (NMFS 1998, Anderson 1998, 1999).

In the Navarro River, up to about 5 miles of the river is innundated by a lagoon when a sandbar forms. Many steelhead rear in this estuarine system year-round, particularly age 1+ and 2+ fish. Closure of the sandbar in the late summer/early fall during the course of a two year study appeared to result in a movement of steelhead upstream and a temporary reduction in growth rate, but this was generally followed by an increase in growth rate a short while later (S. Cannata, CDFG, pers. comm 2000).

Despite their shallowness and warm summer water temperatures, San Gregorio, Pescadero and Waddell creek lagoons are heavily utilized by steelhead for rearing. Smith (1990) documented excellent juvenile steelhead survival and growth when these estuarine systems were either open to full tidal mixing, or were closed and converted to fresh water. In these systems, steelhead growth was poor during periods of warm, stratified water conditions, including long transition periods to lagoons converted to fresh water. Higher inflows in the spring allowed relatively rapid conversion of an impounded lagoon to fresh water, but summertime breaching of sandbars was found to severely alter habitat conditions in the lagoons, including water quality and food availability. Smith concluded that the large numbers and/or large sizes of steelhead that rear during years that have freshwater lagoons can potentially contribute the majority of steelhead smolts produced in these watersheds. An open sandbar was maintained at Pescadero Creek in 1989 to aid work on a Highway 1 bridge, and kept the main embayment cool and well mixed for most of the summer. Steelhead grew rapidly that year, even though numbers of fish were not high. Pescadero has a large, wide embayment which allows good tidal exchange and mouth scour so that substantial raring habitat was created and frequent breaching was not required.

In general, growth and survival of steelhead in Pescadero, San Gregorio, Waddell and Poponio lagoons was good when the systems were open to full tidal mixing or when the lagoons had converted to unstratified, freshwater conditions. Growth and suvival was poor when salinity stratification led to high water temperatures and low bottom dissolved oxygen (Smith 1990).

Data from beach seining activities in the Russian River Estuary under the monitoring program indicate that some juvenile steelhead rearing may occur in this estuary (MSC 1998), but the data are not conclusive. Biological monitoring has generally been conducted before and after artificial breaching events, and since these events have generally occurred in the late summer and fall, biological monitoring has not given a clear picture of how biological organisms utilize the estuary throughout the spring and summer. Logistical constraints have limited seining surveys, and researchers caution that beach seines that have been primarily conducted in the late summer and fall may not be representative of how fish may utilize the estuary in other seasons. However, given the importance of other estuarine systems for juvenile salmonid rearing, it is prudent to assume this estuary provides, or can potentially provide, important rearing habitat as well. The upper portions of the Estuary, which have not been sampled, may also be important for juvenile rearing if water quality is suitable, especially since a coastal fog belt moderates high water temperatures in the summer.

The best available data to assess potential rearing habitat in the Estuary comes from water quality monitoring. Therefore, assessment of the effects of artificial breaching on salmonid rearing focuses on whether suitable water quality can be maintained with the current level of artificial breaching.

Juvenile salmonid rearing is generally thought to occur during the following times (see *Section 1.3*):

- Coho All year, generally rear in tributaries
- Steelhead All year
- Chinook February through June

Under existing augmented flow conditions, the system is basically managed as an estuary (sandbar-open). Under this management plan, water quality is best when the estuary is open to tidal mixing, especially during the lower flows of the summer/early fall months. The longer the sandbar remains closed, the longer stratified conditions result in low dissolved oxygen levels and high water temperatures in deep pools, at least over the short-term. This low flow time may vary from year to year, beginning about when spring flows are reduced to summer levels and ending generally about the time that the rains begin in the fall. Water quality evaluation criteria under estuary managment are applied for juvenile rearing (particularly for steelhead) from May through October (Table 2-1). This schedule would apply after the first time the sandbar is artificially breached during this period.

When the sandbar is breached at current water elevations, flows through the opening are quite high. Juveniles could be flushed out of the estuary before they are ready to leave if strong currents are created within the Estuary. Limiting the height of the water level during sandbar-closed conditions may help to minimize this effect.

2.4 ADULT UPSTREAM MIGRATION

When the rainy season begins, the sandbar generally opens naturally. Rain and increased flow at this time would create good passage conditions for adults migrating up into the river. The peak adult chinook salmon spawning run begins after November, although chinook do begin to gather outside of the river in mid-August.

Adult migration periods for salmonids are:

- Coho November through January
- Steelhead January through March
- Chinook Mid-August through January, with peaks occurring after November

Adult salmonid passage requirements are 1) passage through the sandbar and estuary from the ocean, and 2) good water quality when passage occurs. Artificial breaching provides more passage opportunities than would occur under natural conditions. A key consideration is whether water quality is sufficient when additional passage occurs.

Water quality in the estuary is primarily dependent upon how long the sandbar is closed, and sandbar closure is primarily related to ocean and river flow conditions. Once the sandbar is breached, water quality does not immediately improve in the upstream parts of the estuary, and the sandbar may close again before it does improve. Several successive breaching events may be required to improve water quality in upper reaches.

If the sandbar were to be breached before winter storms help improve water quality in the mainstem Russian River, adult chinook salmon may not be able to pass, and may become trapped in poor quality water. Steelhead and coho salmon adults generally migrate later, and are more likely to move upstream when water quality has improved with higher flows.

Water quality evaluation criteria under estuary managment are applied for adult salmonid passage from August to the first significant rains. If the rains are very late, artificial breaching may provide passage during peak spawning times while water conditions could still be poor in the Estuary or the mainstem river. Anecdotal information may provide information on whether salmonids, particularly chinook salmon, have been caught trapped anywhere in the river.

2.5 JUVENILE OUTMIGRATION

Juvenile fish passage requirements include 1) passage through the estuary to the ocean and 2) good water quality. Smolt emigration is usually complete by early summer. If the sandbar were to close at some time in the late spring, artificial breaching would provide additional passage opportunities in addition to those that would have naturally occurred. This may be a benefit for salmonids that have undergone the physiological changes that prepare them for salt-water conditions. Juvenile salmonid migration generally correlates to the occurrence of spring freshets, among other factors, and water quality at this time would be expected to be better than during the summer in the estuary and the river. Emigration times for juveniles are:

- Coho February through mid-May
- Steelhead March through June
- Chinook February through May

Water quality evaluation criteria under estuary managment are applied for juvenile migration in the spring (Table 2-2). Furthermore, artificial breaching affects the amount of time a closed sandbar could delay juvenile outmigration.

2.6 PREDATION

Artificial breaching of the sandbar creates a passageway that could potentially concentrates juvenile or adult salmonids. This may affect the level of predation by pinnipeds, particularly harbor seals, and occasionally California sea lions and elephant seals. There are currently large self-sustaining populations of harbor seals, and occasionally California sea lions and elephant seals appear in low numbers. Harbor seal populations peak in the late winter and mid-summer (MSC 2000). They prey on adult salmonids during spawning migrations and salmonid smolts during outmigration.

Artificial breaching may potentially increase angling pressure or poaching opportunities on adult salmonids, particularly chinook salmon. An artificial breach may produce a freshwater outflow that attracts chinook into the estuary while water quality or flow is still low. If the fish are trapped in areas of low flow or high water temperatures that stress them, they may be more likely to be caught.

2.6.1 PINNIPED PREDATION

Harbor seals are better able to capture fast moving salmonids if the fish are trapped or stressed. If fish must migrate through a shallow, narrow river mouth, or are trapped within the Estuary when water quality is poor, predators can capture them more easily. An analysis of harbor seal scat samples in the winter of 1989 and spring of 1990 determined that the harbor seals feed primarily outside the estuary on slow-moving or schooling prey (RREITF 1994), rather than on salmonids. While harbor seals fed on lamprey migrating through the estuary, other up-river migrants, including adult salmonids, did not constitute an important part of the harbor seal diet. Predation on migrating juvenile salmonids increased significantly under only one unusual circumstance, coinciding with a large hatchery release, rain, and a closed estuary that trapped the smolts.

To evaluate the risk of increased predation on protected species, two components were developed for predation evaluation criteria: structural criteria, and access criteria (Table 2-3). Structures that concentrate prey increase the potential for predation on protected species. If there are holding areas that favor predators near structures that concentrate salmonids, and if predators are actually present near those structures, protected species may be adversely affected. Only structures that provide predators access to areas that they have not historically reached would affect the level of predation.

Table 2-3 Predation Evaluation Criteria

Category Score	Evaluation Criteria
	Component 1: Structural Criteria
5	No features that concentrate salmonids or provide cover for predators, concentrations of predators not found.
4	No features that concentrate salmonids, predator cover near, predators in low abundance locally.
3	Features that concentrate salmonids, no predator cover near, predators in medium to low abundance locally.
2	Features that concentrate salmonids, predator cover near, predators in medium to low abundance locally.
1	Features that highly concentrate salmonids, predators abundant locally.
	Component 2: Access Criteria
5	Structure does not allow passage of predators, predators not present near structure.
4	Structure does not allow passage of predators, predators present near structure.
3	Structure provides limited passage of predators, or limited passage to areas they are already well established, predators not present near structure.
2	Structure provides limited passage of predators to areas they have historically not been found or have been found in limited numbers, predators present in limited numbers near structure.
1	Structure provides passage of predators to areas they have historically not been found or found in limited numbers, predators present or migrate to structure.

2.6.2 Increase in Angling Pressure or Poaching

Chinook salmon begin to congregate outside the mouth of the Russian River in mid-August. If the lagoon is breached at a high elevation, the effect of an artificial freshet could attract fish into the river when water quality is poor, either in the Estuary or the river. In the past, breaching was done for the purpose of attracting fish into the river for the benefit of the angler (W. Cox, CDFG, pers. comm. 2000). If fish are trapped in water of poor quality, the increase in stress may make them more susceptible to predation. If they are trapped in an area with low flows, they may also be more vulnerable.

As with predation by pinnepeds, if adult chinook salmon are concentrated into areas that increase the risk of being caught by people, or people have access to the fish that they might not otherwise have had, the risk to these fish would be increased.

The previous section identified issues of concern for protected species and critical habitat that may arise from implementation of the Management Plan. Evaluation criteria were developed for effects on water quality, juvenile rearing, passage of juvenile and adult coho salmon, steelhead, and chinook salmon, and for predation risk.

3.1 JUVENILE REARING

The Estuary is part of the critical habitat for rearing juvenile steelhead and possibly rearing in the upper Estuary for chinook salmon. Juvenile steelhead with parr marks (dark bands on their sides) were found in the Estuary in 1997, the year that artificial breaching events were studied earlier in the summer. The sandbar first closed in late March of 1997, unlike 1996 and 1998 when the sandbar first closed much later (July and late August respectively). When juvenile fish undergo the physiolgical change that allows them to make the transition from fresh water to salt water (smolts), they lose their parr marks and their coloration changes into a distinctive silvery color. The presence of juveniles that were not smolts suggests that rearing occurs in the Estuary. A great deal of variability was found year to year in the pattern of sandbar closure and of biological features in the Estuary, and is possible that utilization of the Estuary for salmonid rearing varies from year to year. Chinook smolts were caught in April, May and June of 1993 (RREITF 1994). No chinook were caught that year after the county breached the sandbar on June 4. Sampling was not conducted in the upper reaches of the Estuary, and data are not available to assess chinook rearing in the lower portions of the mainstem Russian River. However, given the importance local estuarine systems for rearing, maintaining good rearing conditions in this critical habitat is an important component in the recovery of these species.

The Management Plan calls for breaching of the sandbar when water levels at the Jenner gauge are between 4.5 and 7.0 feet in elevation. Applying the water quality evaluation critieria under estuary managment for juvenile rearing, based on the number of days the sandbar is closed, scores of 3 or better are generally achieved. Therefore, under current conditions, artificial breaching under the Management Plan is likely to limit poor water quality effects on rearing habitat for steelhead and chinook, and possibly some coho.

Table 3-1 Water Quality Evaluation Criteria under Estuary Managment for Juvenile Rearing

Category Score	Frequency of Artificial Breaching (time sandbar remains closed)	Score*
5	0-5 days	
4	6-10 days	
3	11-14 days	St, Ch, Co
2	15-21 days	
1	> 22 days	

*St = steelhead, Ch = chinook, Co = Coho

When the sandbar is breached, juvenile salmonids could potentially be flushed out of the Estuary before they are ready to leave. Under the current breaching program, the sandbar is generally breached when the water level at the Jenner gauge reaches 4.5 to 7.0 feet. Limiting the height of the water in the estuary before breaching minimizes the risk of adverse effects near Willow Creek, and is likely to have the added benefit of reducing the risk of flushing juvenile salmonids during artificial breaching.

When the sand berm is overtopped or breached artificially, the breach channel is not established instantaneously, and more than one tidal cycle may be required to drain the estuary (RREITF 1994). The development of the channel depends on the difference in water level between the estuary and the ocean, and on the width of the barrier beach. During an artificial breach on October 7, 1993, the development of the channel width was measured. Water level in the Estuary was about 8.9 ft (NGVD). The channel enlarged from the width of the bulldozer used for breaching (about 10 feet wide) to 225 feet within 3 hours.

Recent observations by SCWA staff during artificial breaching events suggest that while water velocity within the breach channel is very high, velocity in the Estuary is not (S. White, SCWA, pers. comm 2000). A hydraulic head between low tide and gauge heights up to 7.5 feet creates a rush of water when the berm is first breached. When it is first dug, the trench is about 10 feet wide and a couple of feet deep, but by the time the water has slowed, the channel can be about 100 feet wide. However, water velocities in the Estuary appear to be nondetectable. Seagulls have been observed floating on the water 50 to 100 feet from the breach. Seals swim within the 20 feet of the wash, but avoid the channel, although occasionally young seals have been observed riding the current out repeatedly. These observations suggest that the risk of juveniles being flushed out during a breaching activity is low.

3.2 ADULT MIGRATION

Adult salmonid passage requirements are 1) passage through the sandbar and estuary from the ocean, and 2) good water quality when passage occurs. Artificial breaching provides more passage opportunities than would occur under natural conditions. A key consideration is whether water quality is sufficient when additional passage occurs, both in the Estuary and in the mainstem Russian River.

As peak migration for adult coho salmon and steelhead occur much later in the year than for chinook salmon, the effects of artificial breaching would most likely occur with adult chinook salmon. Although peak spawning for chinook salmon occurs after November, adults begin to congregate at the mouth of the Russian River in mid-August. When winter rains begin, water quality in the river and Estuary would improve, and it is at this time that ocean conditions would change so that natural breaching of the sandbar is more likely to occur. If artificial breaching of the sandbar were to give chinook salmon access to the Estuary or river while water quality was still poor, stress or mortality could occur.

Applying water quality evaluation criteria under estuary managment for adult salmonids, scores of 3 or better can generally be applied for effects of water quality within the Estuary (Table 3-2). With respect to potential migration for adult salmonids under current conditions, artificial breaching under the Management Plan is not likely to have adverse effects on estuarine habitat.

Table 3-2 Water Quality Evaluation Criteria under Estuary Managment for Adult Migration

Category Score	Frequency of Artificial Breaching (time sandbar remains closed)	Score
5	0-5 days	
4	6-10 days	
3	11-14 days	Co, St, Ch
2	15-21 days	
1	> 22 days	

* St = steelhead, Co = coho, Ch = chinook

Artificial breaching of the sandbar produce freshets that may attract early adult chinook salmon into the Estuary, and if they begin an upstream migration, they may be subjected to increased stress or mortality in the mainstem Russian River if they encounter low flows or poor water quality. Because augmented flows increase the base flow in the river over historical conditions, chinook salmon may not be as likely to experience stranding in low water areas such as riffles, or in fish passage facilities. The lower Russian River can be characterized as primarily glide habitat (S. White, pers. comm. 2000). Preliminary data from the fish ladders at SCWA's inflatable dam at the Mirabel diversion facilities indicate that while chinook may appear as early as mid-August, they generally pass this facility when it has rained, with peak migration occurring after November.

There have been a very small number times when early chinook (August) have been caught in low, warmwater conditions in the lower mainstem, and have been lethargic enough for people to be able to wade out into the river and pick them up. However, this is a highly abnormal occurrence (W. Cox, CDFG, pers. comm. 2000).

While it is possible that a few adult chinook may begin their upstream migration (under natural or artifical breach events) during times when water quality in the river is poor, the primary migration period occurs after November when the rains generally begin. While anecdotal reports indicate that some fish are occasionally affected, augmented flows in the river are likely to reduce the risk to early migrants. Therefore, the risk to the population is likely to be low.

3.3 JUVENILE OUTMIGRATION

Juvenile coho salmon, steelhead and chinook salmon pass through the Estuary during their outmigration period. Steelhead smolts caught in all four years of the MSC study were very fit and plump, suggesting they may be feeding while in the Estuary.

If the sandbar were to close at some time in spring or early summer, artificial breaching would provide additional passage opportunities than would have naturally occurred. Artificial breaching is more likely to occur in late summer or fall, after smolt outmigration. It is important that suitable water quality conditions for passage are maintained in the estuary during passage opportunities. Applying water quality evaluation criteria under Estuary management for juvenile migration results in scores of 3 or better. Artificial breaching under current conditions is not likely to significantly degrade habitat during smolt migration periods. Frequent breaching also benefits salmonid smolts by limiting the time that fish may be trapped behind the sandbar when they are physiologically ready to emigrate to the ocean.

Table 3-3 Water Quality Evaluation Criteria under Estuary Managment for Juvenile Migration

Category Score	Frequency of Artificial Breaching (time sandbar remains closed)	Score
5	0-5 days	
4	6-10 days	
3	11-14 days	Co, St, Ch
2	15-21 days	
1	> 22 days	

* Co = coho, St = steelhead, Ch = chinook

3.4 PREDATION

3.4.1 PINNIPEDS

Because migrating salmonids are concentrated through a breach opening while pinnipeds are present, they could potentially be exposed to an increased risk of predation. The most abundant pinniped species is the harbor seal, and their numbers peak in the late-winter and mid-summer (MSC 2000). In four years of monitoring, seal numbers fell when the sandbar was closed and rose when it opened, whether the breaching was natural or artificial. A breach opening makes it easier for seals to get to a preferred haulout site inside the sandbar. Numbers at Jenner in 1999 were highest during March through April, and numbers fell dramatically after July. Pinnipeds are present in lower numbers at other times of the year.

Artificial breaching activities are most likely to occur during the summer and early fall, rather than during the rainy season. Sandbar closures and breachings were concentrated in fall in three out of four years studied (the exception was 1997, when closures first occurred in late March) (MSC 2000). While the sandbar may be opened naturally at any time of the year, artificial breaching generally occurs during the early part of adult chinook spawning migration, and may occur during the late part of juvenile salmonid migration (although it may occur earlier or later in some years). The sandbar often remains open or breaches naturally during peak adult salmonid migrations and the early portion of juvenile migration, so artificial breaching is not generally required during those times.

Artificial breaching activities can potentially concentrate juvenile or adult salmonids, and does help to concentrate seals. Therefore the score for component 1 is a 2 (Table 3-4). However, peak pinniped population periods and artificial breaching during peak salmonid migration periods do not overlap to a large extent.

Artificial breaching of the sandbar does not increase access of pinnipeds to areas that they have not historically been, although it does appear to occasionally increase access to their preferred haulout sites within the Estuary near the river mouth. Predation by pinnipeds is a natural occurrence, and populations of pinnipeds have historically been well established. Therefore, the score for the second component is 3.

Table 3-4 Predation Criteria Scores for Adult and Juvenile Salmonids

Category Score	Evaluation Criteria	Score*
	Component 1: Structural Criteria	
5	No features that concentrate salmonids or provide cover for predators, concentrations of predators not found.	
4	No features that concentrate salmonids, predator cover near, predators in low abundance locally.	
3	Features that concentrate salmonids, no predator cover near, predators in medium to low abundance locally.	
2	Features that concentrate salmonids, predator cover near, predators in medium to low abundance locally.	Co, St, Ch
1	Features that highly concentrate salmonids, predators abundant locally.	
	Component 2: Access Criteria	
5	Structure does not allow passage of predators, predators not present near structure.	
4	Structure does not allow passage of predators, predators present near structure.	
3	Structure provides limited passage of predators, or limited passage to areas they are already well established, predators not present near structure.	Co, St, Ch
2	Structure provides limited passage of predators to areas they have historically not been found or have been found in limited numbers, predators present in limited numbers near structure.	
1	Structure provides passage of predators to areas they have historically not been found or found in limited numbers, predators present or migrate to structure.	

*Co = coho, St = steelhead, Ch = chinook

While creating an artificial breach through the sandbar has the potential to increase pinniped predation, a wide opening and with ample flows minimizes the risk. When the channel is first dug, it is about 10 feet wide and a couple of feet deep, but by the time water has drained from the Estuary, the channel is generally about 100 feet wide. While the water drains, velocities are high enough that it would be difficult for anything to fish there, including seals. Young seals have been observed to repeatedly ride the wash out, but older seals generally avoid the breach opening during that time (S. White, pers. comm. 2000).

Peak pinniped population periods and artificial breaching during salmonid migration periods do not overlap to a large extent, further reducing the risk to protected species. Because pinnipeds have historically used the natural sandbar opening and the mouth of the Russian River for foraging, a new risk to protected species has not been introduced. Furthermore, artificial breaching activities only occur several times in any year. Therefore, only a low risk to a small portion of migrating salmonid populations is likely to occur.

3.4.2 INCREASE IN ANGLING PRESSURE OR POACHING

Chinook salmon begin to concentrate at the mouth of the Russian River around mid-August, but peak migrations usually occur after late November. In some years, the sandbar opens naturally in the early fall, and adult chinook may enter the river early. Historically, anglers have begun fishing for chinook in August, especially near Duncans Mills. An artificial breach would create an additional passage opportunity, and flows from the river may attract chinook into the Estuary while water quality is poor or river flow is still low.

If adult chinook were concentrated into areas that made them more vulnerable to angling or poaching, the risk to them would be increased. For example, if they were caught on a riffle during low flows, or could not surmount fish ladders because of inadequate flows, they may be at an increased risk. However, with augmented flows, the lower mainstem Russian River is basically one long glide, and flows may be sufficient in most areas to provide passage. There are potential problem areas along many of the riffles, mostly on the lower river below Guerneville, that local fishermen frequent, and also below some of the fish ladders where fish congregate before moving upstream (R. Coey, CDFG, pers. comm. 2000). Some chinook enter the larger tributaries in early pulse rains, and then become stranded when the rains stop and adequate flows have not begun, and this was verified on Feliz and Forsythe creeks in 1999 (R. Coey, CDFG, pers. comm. 2000). There have been a few times when chinook have come in very early, in August, when the water has been low and warm, where the fish have been so lethargic that people could wade out in the river and pick one up. However, this has been a highly abnormal situation (W. Cox, CDFG, pers. comm. 2000).

The Russian River is open to fishing in the fall, and the mouth of the Russian River is reputedly one of the better fishing spots in that area of the coast. Whether chinook salmon are congregated outside of the Russian River or are inside, there are likely to be fishermen there. Therefore, access to the river in itself is not likely to increase exposure to anglers. However, if some early chinook are stranded, they could be subjected to increased fishing pressure.

By providing additional passage opportunities in the early fall, artificial breaching may provide additional passage opportunities for early chinook adults, and if any of these fish migrate into the mainstem when water quality is poor, they may be subject to increased predation or poaching. However, anecdotal reports indicate the incidence of this is low, and video monitoring at the SCWA inflatable dam indicates that most chinook migrate after November. Therefore, while a few fish may occasionally be affected (both under natural or artificial breaches), the risk to the population is likely to be low.

The Russian River Estuary is important for adult and smolt passage for all three protected species. An estuary provides an opportunity for smolts to gradually become acclimated to ocean conditions before their migration out of the river system. The estuary is potentially important critical habitat for juvenile salmonid rearing, particularly for steelhead and chinook, and possibly some coho.

Potential effects were evaluated for steelhead rearing in the Estuary. Potential effects were evaluated for adult and salmonid migration for all three species. The issues addressed in this report are summarized as follows.

1) Water quality
2) Juvenile rearing
3) Flushing juveniles out of the Estuary prematurely
4) Adult upstream migration
5) Juvenile outmigration
6) Predation on salmonids

Effects of augmented flow on habitat in the Estuary will be assessed in *Interim Report 3: Instream Flow Requirements.* The estuarine system is basically mangaged as an estuary (sandbar-open) rather than a lagoon (sandbar-closed) because with augmented flows, artificial breaching of the sandbar is needed to prevent flooding of local property.

Key findings are summarized.

4.1 WATER QUALITY

In 1992, breaching of the sandbar while the height of the water in the Estuary was greater than 9 feet at the Jenner gauge, resulting in a flush of anoxic water from Willow Creek. Under the current plan, the height of the water behind the sandbar is kept below 7.0 feet at the Jenner gauge, although water level may be slightly higher in some instances. Anoxic water flows from Willow Creek have not been documented during the first four years of monitoring.

Water quality in the Estuary is affected by the schedule of artificial breaching, but is not completely determined by it. When the sandbar closes, salinity stratification occurs in deep pools, and changes in dissolved oxygen and water temperature lead to deteriorating water quality in the near bottom layers. Long periods of stratified water conditions can lead to adverse effects for salmonid rearing by reducing water quality or food availability. Water quality monitoring has shown that when the sandbar is breached, tidal action helps to improve water quality. This process occurs most quickly near the mouth of the river, but may take several days at upstream sites. While low DO in the near-bottom layers of the deep pools is associated with sandbar-closed conditions, anoxia can also develop under tidal conditions during neap tides and/or low river flows.

Water quality is generally better when the sandbar is open than after it has been closed for a couple of weeks. Given the general decline in dissolve oxygen levels (and increases in water temperature) over the short-term, particularly in near-bottom layers of deep pools during bar-closed episodes, it appears prudent to limit the duration of bar-closed episodes. Evaluation criteria for water quality give higher scores to breaching activities that minimize the amount of time the sandbar is closed. The plan generally limits bar-closed episodes to 7 to 10 days in duration. The sandbar is breached more frequently under the Management Plan than it was previously, and this may help to limit poor water quality conditions in the Estuary.

It is not known what water quality conditions would be like if the sandbar were to remain closed for an extended period of time. However, with augmented flows, too much water flows to the Estuary to avoid artificial breaching of the sandbar. If the system were to be managed as a lagoon (sandbar-closed), different evaluation criteria for water quality would be needed. Estuary mangagement under alternative flow regimes will be considered in the final BA.

4.2 JUVENILE REARING

Given the importance of local lagoons and estuaries for steelhead and chinook rearing, it is prudent to maintain good quality reaing habitat in the Estuary. While coho salmon may be present in the Estuary, coho salmon are more likely to rear in tributaries. Under current flow conditions, the schedule of artificial breaching helps to limit poor water quality conditions that begin to form immediately after the sandbar closes.

The sandbar is generally breached before the water level at the Jenner gauge exceeds about 7 ft. This practice is likely to reduce the risk of flushing juvenile salmonids out of the Estuary before they are ready to leave over past practices. Observations by SCWA staff during breaching activities indicate that although water velocities through the breach channel are high, velocities several tens of feet within the Estuary are not. Therefore, the risk of flushing juveniles out of the Estuary before they are ready to go is likely to be low.

4.3 ADULT UPSTREAM MIGRATION

Adult salmonid passage requirements are 1) passage through the estuary from the ocean, and 2) good water quality when a passage opportunity exists. Artificial breaching provides more passage opportunities than would occur under natural conditions. A key consideration is whether water quality is sufficient when those additional passage opportunities are made available, both in the Estuary and the river. This is of particular concern for chinook salmon because they begin to congregate at the mouth of the Russian River in mid-August, when poor water quality conditions are most likely to occur.

Peak migrations of adult salmon usually occur after the rains have started. Artificial breaching of the sandbar usually occurs in the late summer or early fall, although it may occur early or late in some years. An artificial breach event may cause a freshet that attracts early chinook salmon. The sandbar is breached more frequently under the Management Plan than it was previously, and this may help to limit poor water quality conditions in the Estuary. Therefore, management actions do not have adverse effects on water quality during periods of adult salmonid migration through the Estuary.

Early chinook salmon may enter the river before rains increase river flows or improve water quality in the lower mainstem of the river. There have been a few occasions where chinook have been trapped in warm water that that have subjected them to stress. However, these occasions have been rare. Augmented flows in the river are likely to reduce the risk of stranding in low-flow, warmwater conditions. Furthermore, peak spawning runs occur after November. While there may be a risk to a few early migrants, the risk to the population of chinook is likely to be low.

4.4 JUVENILE DOWNSTREAM MIGRATION

Juvenile fish passage requirements include 1) passage through the estuary to the ocean and 2) good water quality. If the sandbar were to close at some time in spring, artificial breaching would provide additional passage opportunities than would have naturally occurred.

Juvenile salmonid migration generally correlates to the occurrence of spring freshets, among other factors, and water quality at this time would be expected to be better than during the summer in the estuary. Artificial breaching generally occurs in the fall, although it may occasionally happen earlier. Steelhead smolts caught during four years of biological monitoring have been fit and plump. By limiting the time the sandbar is closed, short-term degradation of water quality is reduced, and migration delays due to sandbar closure are minimized.

4.5 PREDATION

Predation by pinnipeds is a natural occurrence. At issue is the question whether artificial breaching increases the risk to migrating salmonids. Artificial breaching may slightly increase the risk of predation on salmonids by pinnipeds because harbor seals tend to congregate at the sandbar when the bar is open, and because some migrating salmonids may be concentrated in or near the artificial breach opening. A wide breach opening with ample flows minimizes the risk. Peak pinniped population periods and artificial breaching during salmonid migration periods do not overlap to a large extent, further reducing the risk to protected species. Furthermore, artificial breaching activities only occur several times in any year. Therefore, while some migrating salmonids may be affected, the risk to populations of listed fish species is low.

4.6 INCREASE IN ANGLING PRESSURE OR POACHING

Chinook salmon begin to congregate at the mouth of the river as early as mid-August. An artificial breach in the early fall would create an additional passage opportunity for early adult chinook salmon. Because angling pressure in the fall is high both in the river and outside the mouth, artificial breaching will not increase angling pressure. If chinook were to migrate up the river while flows are low or water quality is poor, they could potentially be subject to additional predation or poaching opportunties. However, based on ancedotal reports, the incidence of stressed fish in the river is very low. Furthermore, video monitoring at the fish ladder at SCWA's inflatable dam at Mirabel indicates that most chinook migrate after November. Therefore, while a few fish may occasionally be affected, the risk to the population is likely to be low.

4.7 SYNTHESIS OF EFFECTS

Presently the Russian River Estuary is managed as an estuary (sandbar-open) rather than a lagoon (sandbar-closed). Biological and water quality monitoring since 1996 has shown that under current conditions, artificial breaching under the Management Plan occurs frequently enough to limit poor water quality conditions from developing during rearing and passage periods. The risk to flush juvenile salmonids out of the estuary before they are ready to leave is low. Because angling pressure is high both outside of the river mouth and in the river, providing additional passage opportunities to adult salmon is not likely to increase angling pressure.

While there there may be a small increase in predation by pinneds during portions of salmonid migration periods, the risk to protected populations is low. Artificial breaching may provide adult chinook salmon an opportunity to enter the river while water quality is low, and early migrants may potentially be stressed or subject to increased predation or poaching. Although there may be a risk to a few early migrants, the risk to the population of chinook is likely to be low.

Artificial breaching activities under the Management Plan are likely to adversely affect the listed fish species because there is a low risk of increased predation on salmonids by pinnipeds if salmonids are concentrated in or near the artificial breach opening, and because early chinook salmon may have additional opportunities to migrate up the river while water conditions are poor. Because the risk is likely to be confined to only some individual fish for limited portions of salmonid migration periods, the risk to protected populations is low.

Artificial breaching activities under the Management Plan under current flow conditions are not likely to adversely affect the designated critical habitat of the listed fish species.

It may seem to the reader that it is contradictory to state that there is a low risk of adverse effects to protected populations, along with the statement that the proposed project is likely to adversely affect the listed species. However, the first statement is a general assessment of the risk to the larger population of the protected fish species, while the second statement reflects the possibility that one or more fish might be harmed by certain activities. These conclusions will assist NMFS with preparing a BO which may include an incidental take statement (with regard to the individual fish that may be harmed by the proposed action), as well as a determination of whether the proposed action is likely to jeopardize the continued existence of the species.

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