5.0 ENVIRONMENTAL BASELINE

5.1 OVERVIEW

The environmental baseline is defined as "the past and present impacts of all Federal, state, or private actions and other human activities in the action area, including the anticipated impacts of all proposed Federal projects in the action area that have undergone Section 7 consultation and the impacts of state and private actions that are contemporaneous with the consultation in progress" (50 CFR 402.02, "effects of the action," emphasis added). It is an analysis of "the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat and ecosystem, within the action area," including designated critical habitat. "It does not include the effects of action under review" (ESA Section 7 Consultation Handbook [March 1998] p. 4-22, emphasis added).

When the consultation is for an ongoing action, the task of assessing the effects of the environmental baseline is complicated by the fact that certain preexisting aspects of the ongoing project are also part of the environmental baseline, while other proposed aspects represent the proposed action that is the subject of the consultation. It is important to recognize a fundamental principle of an ESA § 7(a)(2) consultation. Section 402.03 provides: "Section 7 and the requirements of this part apply to all actions in which there is discretionary involvement or control." Accordingly, the ESA requires a Federal agency to consult on actions that it proposes to authorize, fund, or carry out pursuant to its discretionary authority. See also 50 CFR § 402.02 "*action*" and ESA § 7(a)(2). Thus it follows that the ESA does not require consultation on any elements of the pre-existing project that are beyond the agency's current discretion or control, i.e., anything that is part of the environmental baseline. In addition, the continuing effects of those aspects of the FCRPS dams and USBR projects that are not subject to Action Agency discretion, such as their existence and operations necessary to satisfy Congressionally mandated purposes (e.g., flood control and irrigation) are considered part of the environmental baseline.

The effects of the project that must be considered as part of the environmental baseline are a subset of all environmental baseline effects in the action area. The continuing effects of the project's past construction and operation must be considered with the effects of past or present actions and other human activities affecting the species and their habitat within the action area.

Environmental baseline effects are evaluated in relation to the biological requirements of the listed species. The ESUs differ in how they use habitat in the action area, but all rely on this habitat during one or more stages in the life cycle. Uses include adult holding, spawning, incubation, rearing, and migration. The biological requirements of the species include conditions sufficient to satisfy these uses, thus contributing to the survival and recovery of the ESUs to naturally reproducing and self-sustaining population sizes such that protection under the ESA would become unnecessary. Sections 5.4.1 through 5.4.13 review the status of habitat and other factors within the action area that affect viability for each ESU. If critical habitat would be affected, NOAA Fisheries reviews the environmental baseline conditions of constituent elements: substrate, water quality, water quantity, water temperature, water velocity,

cover/shelter, food (primarily for juveniles), riparian vegetation, space, and safe passage conditions.

5.1.1 Action Area

The action area for an ESA consultation is described by the Services' joint implementing regulations (50 CFR §402.02) to mean "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The action area is not delineated by the migratory range of the species affected by the project unless that area is also directly or indirectly affected by the proposed actions. NOAA Fisheries defines the action area for this consultation as:

- The mainstem Columbia River, including and downstream of Libby and Hungry Horse dams and reservoirs; the Snake River below the confluence with the Salmon River; and the Clearwater River down to and including Dworshak Reservoir and Dam, down to and including the Columbia River estuary and plume (i.e., near-shore ocean).

- The estuary and nearshore environment affected by water management operations, including the area between the upstream limit of tidal influence at Bonneville Dam (approximately River Mile 146), the mouth of the Columbia River, and the ocean plume.

- The 4th-field Hydrologic Unit Code (HUC)[1] tributary subbasins where the Action Agencies have proposed non-hydro offsets for effects of their proposed hydro operations (Methow, Wenatchee, and Entiat subbasins).

- The area affected by USBR's conservation measures in the Upper Salmon, Little Salmon, Lemhi, Upper John Day (including the South Fork), North Fork John Day, and Middle Fork John Day subbasins and BPA's conservation measures in the Okanogan subbasin.

- Redfish, Alturas, and Pettit lakes and the tributaries that connect them to the Snake River, due to the activities associated with the safety-net hatchery programs for sockeye.

- Lower South Fork Clearwater River and Lower Selway River downstream to the confluence with the North Fork Clearwater River, due to the activities associated with the Nez Perce Tribal Hatchery for Snake River fall chinook salmon.

- All additional areas directly or indirectly affected by the 19 USBR projects.

[1] In this Opinion, "subbasin" refers to an area within a Hydrologic Unit Code 4 (HUC 4) as defined by the United States Geological Survey (USGS). Subbasin names apply to specific 8-digit HUC codes as described by the USGS (http://water.usgs.gov/nawqa/sparrow/wrr97/geograp/huc_name.txt and found also at http://cfpub.epa.gov/surf/locate/index.cfm).

- All additional tributary spawning areas which are accessible to listed adult salmon or steelhead that are affected by the Updated Proposed Action. There could be a difference between the UPA and the reference operation in the amount of marine derived nutrients returning to spawning and rearing areas due to a difference in the number of adult fish returning to spawn and die. However, the evidence that these relationships are significant in any given watershed is largely inferential, as discussed in Section 5.2.3 and in Section 6, and the topic is the subject of ongoing research.

The action area for this consultation is shown in Figure 5.1.

5.1.2 Biological Requirements and Essential Habitat Features within the Action Area

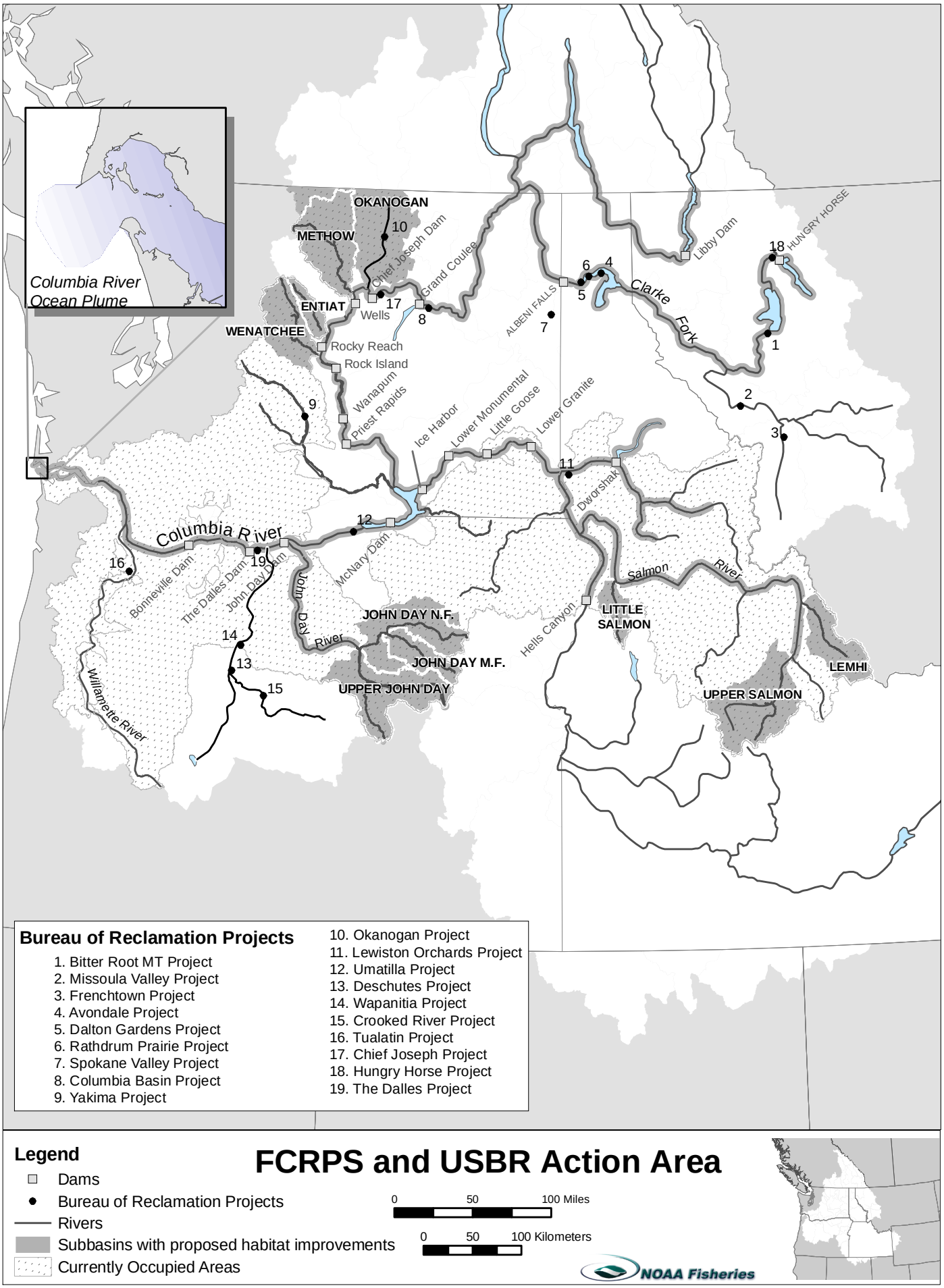
Biological requirements can be expressed as those habitat conditions or survival rates within the action area that support a sufficient number and distribution of viable populations (i.e., populations with adequate abundance, productivity, spatial structure, and diversity) necessary for the survival and recovery of the ESU. The factors that directly influence the viability of a population, and thus are relevant for NOAA Fisheries' assessment of its status within the action area, are the habitat conditions and survival rates associated with properly functioning salmonid habitat. For designated critical habitat, they are the essential physical and biological features. NOAA Fisheries expects to refine its assessment of biological requirements necessary for survival and recovery in the course of recovery planning. Until recovery plans are adopted, NOAA Fisheries' assessment of biological requirements is conservative.

Essential features of designated critical habitat (i.e., for three ESUs of SR salmon) include substrate, water quality, water quantity, water temperature, food, riparian vegetation, access, water, velocity, space, and safe passage. These features also describe the habitat factors associated with viability for all ESUs. The specific habitat requirements for each ESU differ by life history type and life stage. These are described in more detail for each ESU in Sections 5.4.1 through 5.4.13.

The survival rates associated with properly functioning habitat conditions also define the biological requirements. In most cases, the specific survival rates associated with properly functioning conditions cannot be quantified. However, general approximations of juvenile survival rates associated with unimpounded river migration are described in Section 5.2.2.3.1.2 and in the ESU-specific sections, and these are compared to juvenile survival rates under the environmental baseline. A similar, although qualitative, comparison is provided for adult survival rates in Section 5.2.2.3.3. and in the ESU-specific sections.

In general, the closer the action area habitat conditions and survival rates are to those under which the species evolved, the more likely it is that the biological requirements would be met. For this reason, Sections 5.2 and 5.3 review the current habitat features of the action area in the context of historical conditions. For some habitat features, a more specific definition of biological requirements is possible. For example, a total dissolved gas level of no more than 120% is a biological requirement of juveniles and adults migrating through the FCRPS, as described in Section 5.2.1.

Figure 5.1 The action area for this consultation. The ten subbasins where the Action Agencies have proposed habitat improvement projects are shaded grey.



5.2 SUMMARY OF THE ENVIRONMENTAL BASELINE

5.2.1 Reference Operations at Mainstem FCRPS Projects

In addition to the continuing effects of past FCRPS operations and additional USBR project operations on the listed species, the environmental baseline for this consultation includes the continuing effects of those aspects of the FCRPS dams and USBR projects that are not subject to Action Agency discretion. Unlike an original dam construction or FERC relicensing situation where an action agency has authority for the option of not building or decommissioning a project, the Action Agencies lack such authority with respect to FCRPS. For an ongoing action such as hydro operations, the future existence of the project is, to a significant extent, outside the Action Agencies' discretion and thus part of the environmental baseline. For purposes of this consultation, NOAA Fisheries must, where possible, determine what effects of FCRPS operations on the listed species and critical habitat are attributable to the existence rather than the proposed operations of the dams.

With respect to the FCRPS dams and USBR projects, it is clear that each of the dams already exists, and their existence is beyond the scope of the present discretion of the Corps or USBR to reverse. Conversely, many aspects of the management of river flow at the dams are within the Action Agencies' scope of discretion, and thus the effects of that management are attributable to the proposed action. Beyond these obvious conclusions, however, the limits of discretion are difficult to define.

Similar to their lack of authority to significantly modify structures, the Corps and the USBR do not have the discretion to abandon some operations. Flood control, navigation and irrigation are examples of Congressionally authorized FCRPS project purposes, as is some level of power generation to serve demand. As an example, Congress has not prescribed precisely how the Corps must achieve its flood control responsibilities to protect public safety and property, but it is clear that the Corps is obligated by statutory mandate to provide such a benefit. USBR is required by Congress to meet its non-discretionary obligation to deliver water for irrigation. BPA is obligated to market and transmit some level of power, although the precise level is not defined. Thus, some aspects of operations like flood control, irrigation, navigation and power generation may be considered part of the environmental baseline. The Action Agencies' Updated Proposed Action contains both discretionary and non-discretionary actions to provide for Congressionally authorized project purposes, as described above.

Although a jeopardy analysis calls for distinguishing the effects of the existence and non-discretionary operations of the FCRPS dams and USBR projects from the effects of the proposed action, it is beyond NOAA Fisheries and the Action Agencies' technical ability to do so with analytic precision for the FCRPS dams and USBR projects.[2] This is due in large part to the fact that mainstem Snake and Columbia river dams are structures in a river through which both water and fish must pass each year. It is analytically impossible for NOAA Fisheries to assess the projects' environmental baseline effects without assuming some sort of operation for the environmental baseline. Ideally, this environmental baseline operation would meet all of the

[2] The USBR did identify non-discretionary irrigation commitments associated with six of the 19 projects included in this consultation: the Yakima, Okanogan, Bitterroot, Big Flat, Frenchtown, and Dalton Garden projects.

Action Agencies' non-discretionary obligations. A major difficulty with characterizing a non-discretionary operation is that it varies dynamically as a function of the available natural water supply. There may also be numerous operational ways to achieve the non-discretionary objectives.

Therefore, for purposes of this consultation, NOAA Fisheries, with the assistance of the Action Agencies, developed a "reference operation" that serves as an operational surrogate for the hydro portion of the environmental baseline. The reference operation theoretically helps determine the least amount of adverse effect to fish that could be achieved given the existing structures. NOAA Fisheries used this theoretical reference operation to estimate the fish survival associated with the hydro portion of the environmental baseline. This reference or "baseline" level of survival was then compared to the fish survival level associated with the hydro portion of the proposed action to determine the hydro effect. It is important to recognize, however, that the reference operation serves as a point of reference for measuring effects of the proposed hydro operation, i.e., the difference between the two operations represents the effects caused by the Action Agencies' exercise of discretion to achieve all authorized project purposes. As a result of developing and modeling an FCRPS reference operation to maximize fish benefits (one that does not acknowledge other statutory purposes – e.g., navigation, flood control, irrigation and power), the reference operation overestimates the beneficial effects that the FCRPS can actually achieve.[3] As a result, the reference operation is a theoretical operation that the Action Agencies cannot implement, because it fails to meet all the authorized purposes of the projects or the Action Agencies lack the discretion to implement it.. However, its development allowed the consultation to move forward without having to go through the process of trying to precisely determine the extent of the Action Agencies' discretionary operations.

In developing the reference operation, as further described in Appendix D, NOAA Fisheries adjusted the operational parameters for the FCRPS to maximize fish survival based on the best science available and guided by NOAA Fisheries' juvenile fish passage strategy, which was originally developed in the 2000 FCRPS Biological Opinion (Section 9.6.1.4.1) and has been subsequently updated for this Opinion (Section 5.2.1.1.1.2). For example, the preferred passage method for most juvenile salmonids in the strategy is spillway passage, since spilling water over the spillways up to the current state water quality gas standard level is the option that provides dam passage with the least mortality, and therefore the reference operation calls for the use of additional spill for fish passage.

Several commenters on the September 2004 draft of this Opinion stated that restricting the reference operation maximum flows and fish spill levels to the total dissolved gas level of 120% below the dams unduly limits the reference operation from achieving maximum fish survival. Instead, they recommended a higher level of voluntary spill (e.g., up to 125% total dissolved gas (TDG)) to further improve fish survival under the reference operation. NOAA Fisheries notes that Appendix E of the 2000 FCRPS Biological Opinion provided a spill risk assessment that showed that voluntary fish spill to a tailrace level of 120% TDG, or to a 115% forebay level at the next downstream dam, was not unduly harmful to salmon. Even at a low level of gas

[3] These effects are not over-estimated for the six USBR projects for which the USBR identified non-discretionary irrigation withdrawals. These are the Yakima, Okanogan, Bitterroot, Big Flat, Frenchtown, and Dalton Garden projects.

supersaturation, e.g., 110% TDG, some signs of gas bubble trauma (GBT) will develop if fish exposure to that level of gas is long enough or their depth is shallow, i.e., less than one meter. Biological monitoring for signs of GBT in juvenile and adult salmon migrants has been pursued for the past nine years. The monitoring results have shown the incidence of GBT is low if the TDG levels can be managed at or below 120%. A component of this outcome is likely due to depth compensation. Above the 120% TDG level, GBT signs and their severity increase. If TDG levels range between 125-130%, the incidence of more severe signs increases dramatically, as it does in high runoff conditions with large amounts of involuntary spill.

Based on this extensive background of biological monitoring information, and in recognition of total maximum daily load limits for the mainstem Columbia and Snake rivers set by the states of Oregon and Washington and the USEPA, NOAA Fisheries continues to provide voluntary spill for fish passage up to the 120% tailrace and 115% forebay gas cap limits in the reference operation. NOAA Fisheries finds that these TDG levels are safe for both juvenile and adult salmonids. Additional spills resulting in TDG levels above these limits will cross a threshold at which the risks of GBT-related signs and mortality will exceed the improvement in fish passage. Lacking the ability to identify a safe TDG limit between 120% and 125% with an allowance for depth compensation, and because of variations in TDG measurements resulting from spill management at FCRPS hydropower projects, NOAA Fisheries believes that a change in the current gas cap limits for voluntary fish spill in the reference operation is not prudent at his time.

NOAA Fisheries received comments on the draft Opinion from several commenters questioning why RSW installation was limited to Lower Granite and Ice Harbor dams in the reference operation when the UPA includes RSWs at Lower Monumental and Little Goose dams, and long-term planning through SCT includes RSWs at all four lower Snake Dams. Such comments reflect a fundamental misunderstanding of the function of the reference operation – it is the reference operation of the existing structural configuration of the FCRPS dams. It does not represent NOAA Fisheries' vision of how the existing structures could be modified if the Action Agencies had unlimited funds and unlimited discretion.

In Section 7 consultations, the environmental baseline is a tool used to evaluate the status of the species if the proposed action were never implemented, i.e., the environmental baseline is the "no action" alternative. As such, the environmental baseline evaluates the status of the stocks with the dams in place as currently configured, because those actions have already been undertaken. The environmental baseline does not and cannot include future discretionary changes to those structures. Because they are discretionary, such changes would have to be analyzed as part of the effects of the action.

Although the structures themselves must necessarily be fixed in order for the environmental baseline to be a true reference point from which to measure the effects of the action, the structures cannot be evaluated in isolation. Since water necessarily flows through the projects every year, NOAA Fisheries must posit some operational regime for those existing structures. The true environmental baseline is the existing structures operated solely to meet the non-discretionary obligations of the action agencies. However, unlike the structural configuration of the environmental baseline, the operational configuration of the environmental baseline is

exceedingly difficult to determine, given all of the various possible permutations of the FCRPS. Therefore, NOAA Fisheries and the Action Agencies determined instead to posit a reference operation that would provide the maximum benefits for listed fish, regardless of discretion. Nevertheless, the reference operation is only that – an *operational* regime for the existing structures designed to allow NOAA Fisheries to evaluate the "no action" alternative.
Also in the reference operation, flows were managed to the levels providing the greatest benefits with the guidance of available science. Downstream transportation of juvenile salmonids presented special considerations. Since the dams are currently configured to collect and bypass listed juvenile fish into barges for transport around FCRPS projects, the reference operation also includes a transportation operation that utilizes existing fish passage facilities to the extent that, in NOAA Fisheries' judgment, transportation improves survival, or where it provides the same level of survival as the proposed action.

For this Opinion, NOAA Fisheries developed a quantitative analysis showing fish survival under a hypothetical reference operation of the FCRPS, as described in Appendix D. NOAA Fisheries used the results of this reference operation analysis to compare with its quantitative analysis of fish survival under the effects of the proposed near- (2004-2009), intermediate-, (2010-2013), and long-term (2014) hydro operations, also presented in Appendix D and Section 6.0. It is important to recognize, however, that the reference analysis is an analytic tool used to demonstrate quantitative differences in survival rates (also referred to as survival gaps) that, although expressed numerically, are, at best, an approximation of actual survival differences. NOAA Fisheries necessarily must qualify the output of its quantitative analysis by recognizing that there are also unquantifiable factors that cannot be represented in the numbers. NOAA Fisheries considers these limits to its analysis when reaching conclusions in Section 8.0.

One commenter on the draft version of this Opinion argued that, by including all measures to improve fish survival adopted since the original construction of each FCRPS project, the reference operation fails to identify the survival benefits already achieved by such changes in project configuration and operation. This commenter also suggested that, because certain aspects of the reference operation may be unachievable within the limits of Action Agency discretion, the reference operation should not be used as the target to avoid jeopardy but may be more useful as an FCRPS target for recovery planning.

Although some historical context could be provided by analyses of fish survival through the migration corridor at various points in time, such information would have no bearing on this consultation. NOAA Fisheries is tasked with determining whether operating and modifying the existing FCRPS as proposed would jeopardize the continued existence of the species. Some of the actions assumed in the reference operation may exceed the authorities of the Action Agencies to effectuate. However, the Action Agencies have been unable to define all such limits to their authorities. NOAA Fisheries assumes that all fish survival-enhancing actions not clearly outside of agency discretion should be included as part of the reference operation to conservatively estimate the least mortality possible from the existing FCRPS structures.

Several commenters on the September 2004 draft of this Opinion expressed concern that the modeling conducted to estimate the "survival gap" failed to quantify or consider survival risks inherent in the environmental baseline (e.g., Pacific Decadal Oscillation, global climate change,

etc). These naturally occurring population risk factors are not considered in the survival gap analysis but are considered as part of the environmental baseline (see Section 5.3) and were considered in developing the conclusion section (8.0) of this Opinion. It may be that the existence of the FCRPS dams and their discretionary operations affect the response of fish populations to these risk factors (e.g., reduced turbidity during the spring freshet caused by the existence of the projects and/or discretionary project operations may make young fish more vulnerable to predation during adverse ocean conditions), but there are no data available to model such a theoretical effect.

5.2.1.1 Reference Operation Synopsis

As described above, the reference operation defines an operation of the existing FCRPS structures in a way that maximizes the survival of all listed species without regard to the authority of the Action Agencies to actually operate the structures in such a manner. Key operational elements of the reference operation are:

- Federal storage projects are operated as run-of-river dams; however, a winter-spring pre-draft operation was necessary at FCRPS storage projects to reduce high TDG levels during the spring freshet.
- Federal storage projects are managed to achieve refill by June 30.
- Spill occurs at mainstem dams on a 24-hour basis to the total dissolved gas cap from April to mid-September, except no spill is provided at four collector dams during summer.
- Federal storage projects are drafted as needed to meet salmon flow targets.
- Flow depletions associated with USBR operations of certain irrigation projects that are not covered by a separate biological opinion are removed[4] (see Appendix B of the UPA).
- RSWs are operated on a 24-hour basis at Lower Granite (in spring only) and Ice Harbor dams.
- The corner collector at Bonneville Dam Second Powerhouse is operated on a 24-hour basis.
- Existing sturgeon and bull trout ESA operations continue at Libby and Hungry Horse dams.
- All FCRPS mainstem reservoirs are operated at minimum operating pool elevations.

[4] The exception is USBR identification of non-discretionary irrigation commitments associated with six of the 19 projects included in this consultation: the Yakima, Okanogan, Bitterroot, Big Flat, Frenchtown, and Dalton Garden projects.

Details regarding the structures and operations included in the reference operation and the transportation operations in the reference operation follow.

5.2.1.1.1 – Fish Passage Facilities, Reservoir Elevations, and Structural Configurations at the Corps Mainstem Lower Columbia and Lower Snake River Dams Considered In the Reference Operation

5.2.1.1.1.1 - Juvenile Fish Passage Facilities**.** Specific facilities and operations are provided at all eight of the Corps' lower Columbia and lower Snake hydroelectric projects to provide juvenile salmon and steelhead with alternative passage routes through the dams to avoid turbine passage. These passage routes include powerhouse bypass systems, sluiceways, and spillways. Powerhouse bypass systems are composed of intake screens that guide fish away from the turbines intakes, collection channels to carry fish through the dam, and outfalls to deposit fish below the dam. Sluiceways carry surface water, debris, and fish in channels through the powerhouse, and spillways pass water and fish directly through the dam and are separate from the powerhouse. Some spillways are modified to pass water and fish over the top of the spillway, thereby providing a passage route near the surface rather than through the usual deep spillway gates. Powerhouse bypass systems are operated continuously during the fish passage period from April through November and are maintained according to criteria in the Corps' annual Fish Passage Plans. Spillways and sluiceways are operated for fish passage from April through August, except in the summer months at the fish transport dams.

- **Powerhouse Bypass Systems.** Powerhouse bypass systems use two submersible fish screen designs to guide fish away from turbine intakes and into juvenile bypass systems: a standard-length submersible traveling screen (STS) and an extended-length submersible bar screen (ESBS). STSs are currently installed at Lower Monumental, Ice Harbor, John Day, and Bonneville dams. ESBSs are currently installed at Lower Granite, Little Goose, and McNary dams. The Dalles Dam powerhouse does not have a mechanical screen bypass system. The intake screens guide migrating juveniles from turbine intakes into gate wells. Fish guidance efficiency (FGE) is a measure of how efficiently intake screens guide juveniles out of turbine intakes. Higher FGE equates with higher diversion of the migrants away from turbine passage and into the bypass system. Once guided into gate wells by intake screens, fish exit through orifices to a collection channel extending the length of the powerhouse. After primary dewatering, the channel conveys fish and the remaining orifice water flow either directly to the river below the dam at the tailrace outfall or to a fish sampling and holding facility, where fish health can be examined and fish tags detected. Lower Granite, Little Goose, Lower Monumental, and McNary smolt sampling facilities include loading flumes so that collected juveniles can be transported downstream in truck or barges.

- **Spillways and Removable Spillway Weirs.** The spillway of any of the Corps' eight mainstem dams consists of a forebay, multiple spill gates, an ogee, a stilling basin, and a tailrace. Most spillway gates are built from a radial design with a 60-foot radius and 50-foot width. However, the spillways at Bonneville and McNary dams have vertically operated lift gates of similar width. The number of gates per spillway varies from 8 to 10 at lower Snake River dams to 18 to 23 at lower Columbia River dams. The ogee

maintains the shape of the spillway flow between the gates and the stilling basin. All of the spillways are equipped with flow deflectors that help reduce the amount of dissolved gas produced at a given level of flow; these are located on the ogee sections at elevations specific to each project. Spillways are the preferable passage route through dams, because fish survival is usually higher through spillways than through the other available passage routes (Ferguson *et al*. 2004c). With the exception in the summer at Lower Granite, Little Goose, Lower Monumental, and McNary, the four transport projects, the spillways are operated to pass juvenile fish at all eight dams throughout the fish passage season. Juvenile passage studies at each dam have contributed to the development of specific spill gate openings, operational patterns, and daily timing to optimize the number of fish passed through the spillway and their survival. For example, the operation termed "bulk spill" has recently been evaluated at Ice Harbor and Lower Monumental dams to determine if this operation improves spillway survival. The "bulk spill" operation maximizes the water volume per spill bay, with fewer bays opened than a "normal" spill operation, which spreads spill over all spill bays. For example, NOAA Fisheries' evaluated the survival of juvenile Snake River fall chinook through bulk spill in the summer of 2003 at Ice Harbor Dam and found a mean survival of 96% (Absolon *et al.* 2003). This survival estimate amply exceeded NOAA Fisheries' previous summer estimates in 2000 (88.5%) and 2002 (89.4%) (Eppard *et al.* 2002a, 2002b) at Ice Harbor under the normal spread-out spill condition. The results of further evaluations of the "bulk spill" condition in the spring and summer of 2004 at Ice Harbor and the spring of 2004 at Lower Monumental are not yet finalized by NOAA Fisheries. Several commenters pointed out that, since "bulk spill" can be implemented now, any potential survival increases attributed to it in the 2010 UPA operation should also be included in the reference operation. NOAA Fisheries agrees with the comment, so the survival increases attributed to the "bulk spill" operation are now included in both the reference and proposed operations.

To take advantage of the tendency of juvenile fish to migrate in the upper one-third of the water column, the Corps developed the removable spillway weir (RSW) at Lower Granite Dam that passes fish and water at the river surface rather than a depth of 40 or 50 feet through the usual spill gate opening, which is below the radial gate. Recent studies at Lower Granite have shown that the RSW surface spill is particularly effective in attracting and quickly passing juvenile migrants through the dam. Other spill gates across the spillway are opened in conjunction with the RSW bay opening to ensure good tailrace conditions for speedy fish exit from the tailrace.

Although not yet in place, an RSW for Ice Harbor is under construction and should be installed and operational prior to the 2005 spring migration. This RSW is considered part of the reference operation configuration because of the certainty of its existence at Ice Harbor Dam prior to the 2005 spring migration (i.e., funding has already been obtained, design is completed, and construction is currently underway).

- **Sluiceways.** In the original configuration of several dams, sluiceways were built adjacent to the powerhouse to pass forebay debris to the tailrace. Early passage studies found that these sluiceways passed juvenile migrants through the dam quite effectively. Like RSWs,

sluiceways pass surface water, taking advantage of the juvenile fish tendency to migrate in the upper portion of the water column. The Dalles Dam, while lacking a powerhouse bypass system, does have a sluiceway on the upstream face of the powerhouse that extends along the length of the powerhouse. Several surface weir gates pass water and fish, which would otherwise have likely passed into turbine intakes, from the forebay into the sluiceway channel and through the dam to the sluiceway outfall. The newer powerhouse at Bonneville Dam was originally configured with a sluiceway adjacent to the powerhouse. Studies indicated that the sluiceway surface flow was effective in attracting and passing juvenile migrants from the forebay. This sluiceway was recently re-configured to maximize fish passage survival and effectiveness.

- **Reservoir Elevations**. The reference operation includes operation of lower Columbia River reservoirs at minimum operating pool (MOP). This is because the presence of dams in the migratory corridor results in some migrational delay (Raymond 1969, 1979), thereby influencing juvenile migration speed and timing. Operation of reservoirs at minimum operating pool (MOP) reduces the cross-sectional area of the reservoirs, increasing water velocity at the same flow. Juvenile migrants exhibit a strong flow/travel time relationship (Williams *et al.* 2004), and since juvenile migrants are substantially delayed by the dams and reservoirs in the FCRPS (Raymond 1979), a decrease in travel time results in fish (particularly steelhead) arriving at the estuary in a more timely manner. In the low-flow year of 2001, the in-river survival of steelhead from Lower Granite to Bonneville Dam was 4.2% (NOAA Fisheries 2004d).

  A reviewer noted that, by lowering the John Day reservoir to MOP, shallow water rearing habitat would be affected, particularly for SR fall chinook. Based on Corp of Engineers data, it is estimated between approximately 3800 and 4500 acres of emergent marsh-riparian habitat could be affected under a reference operation that holds John Day pool at MOP elevation. However, it is expected that, by reducing fish travel time through lowered reservoirs, fish exposure to pikeminnow predation would be reduced in lower Columbia River pools like John Day, thereby increasing survival, particularly during the warm summer months for migrating SR fall chinook. In addition, based on PIT-tag migration rate data, juvenile SR fall chinook are migrating rapidly through the 146-mile lower Columbia River reach (average travel times ranging between 5 and 10 days), with travel times ranging from 3-4 up to almost 11 days through the John Day reservoir during the last seven years at a higher pool elevation than MOP (Ruff and Ross 11-11-04 memo). Based on these fish travel times, use of shallow water habitat in the John Day pool and other lower Columbia River reservoirs by SR fall chinook would likely be limited. The reference operation includes operation of lower Snake River reservoirs within one foot of MOP.

5.2.1.1.1.2 - Juvenile Fish Passage Strategy**.** The reference operation was developed based on a strategy to increase survival of juvenile outmigrants through the FCRPS, as guided by two key biological principles: protecting biodiversity and favoring fish passage solutions that best fit the natural behavior patterns and river processes (ISAB 1999). The purpose of this fish passage strategy statement is to provide general guidance on dam passage priorities included in the reference operation.

Conventional spillways and surface bypass routes, such as the RSW at Lower Granite and the corner collector at Bonneville, are the preferred passage routes for juvenile salmonids. These are the baseline against which other passage routes are measured. The body of research evidence indicates that juvenile survival is generally highest through spillways and surface routes, and that passage delays are reduced. Therefore, measures that increase juvenile fish passage over FCRPS project spillways and surface routes are the highest priority, unless it can be shown that alternative passage improvements would provide comparable survival. This assumes that spillway and surface routes are implemented in a biologically safe manner to maintain appropriate water quality, while ensuring adequate juvenile egress conditions in the tailrace and minimizing effects on adult passage.

Turbine intake screens and bypass systems provide the best protection for those fish that enter turbine intakes. Juvenile fish are either collected for downstream transport or released at tailrace outfalls. The least preferable route of passage for fish is through turbines, where a generally higher mortality rate occurs due to direct mechanical injuries and adverse pressure changes incurred while passing through the turbine. Further, indirect mortality is likely a significant problem downstream of the powerhouse, where disoriented fish are vulnerable to predation.

5.2.1.1.1.3 - Adult Fish Passage Facilities. The reference operation anticipates that the existing adult passage facilities will be operated the same as in recent years. Adult salmon and steelhead pass upstream through the eight Corps' dams by means of fishways that were installed as part of the original project construction. The fishways typically consist of an entrance gallery and ladder, a diffuser system that provides additional water at the ladder entrances (to attract fish from the tailrace), and a flow-control section at the ladder exit that maintains ladder flow over various forebay elevations. Observation areas are established in each ladder to monitor upstream progress (i.e., fish-counting stations). Criteria for the operation of the ladders and entrances are specified in the Corps' annual Fish Passage Plans, and facilities are inspected regularly throughout the fish passage season to ensure correct operations. The ladders at Bonneville and Lower Granite dams have traps used for broodstock collection, research, and monitoring. Bonneville, McNary, Ice Harbor, and Lower Granite ladders have PIT-tag detection capability. Migrational delays are most likely to occur at fish ladder entrances, in the collection galleries (at junctions between galleries and ladders), and when the traps are operated. Injury related to adult fish passage facilities is usually minimal. However, system failures (e.g., displacement of diffuser gratings in the entrance pools) can result in significant injury and mortality.

Adults also pass downstream through the dams. After spawning adult steelhead (kelts) may migrate to salt water for a subsequent repeat spawning. Adult salmon may overshoot their natal stream and fall back through one or several dams. Downstream passing adults can pass through any of the routes provided for juvenile passage (bypass systems, spillways, RSWs, or sluiceways), or they can pass through turbines.

5.2.1.1.2 Juvenile Fish Transportation Program. The juvenile fish transportation program consists of the collection of juveniles from the screened bypass facilities at Lower Granite, Little Goose, Lower Monumental, and McNary dams and transporting these fish in barges or trucks to release points below Bonneville Dam. The strategy of this program is to avoid the additional

mortality that juvenile salmon would experience if they were left in-river to migrate. Extensive research has been conducted evaluating the effects of this management action (Williams *et al.* 2004, Anderson *et al.* 2004).

The reference operation incorporates juvenile transportation as a management measure to the extent it is supported by current research data. Data from transport studies conducted from 1995 through 2001 using PIT- tag technology have provided a much higher level of understanding about the effects of transportation. Also, efforts have been made over the years to improve fish passage conditions for in-river migrants by managing both spill and flow in the mainstem migration corridor. Adequate migration conditions for fish that remain in-river are essential for them to serve as a suitable control group. The results of these transportation studies are presented in the *Effects of the Federal Columbia River Power System on Salmon Populations* memo (Williams *et al.* 2004). The reference operation reduces reliance on transportation during the month of April. This decision reflects a trend observed in the transportation study results that indicate little benefit exists from transporting spring/summer chinook during April. During low-flow years, the reference operation placed more reliance on transportation by eliminating spill in May and June, because steelhead have shown very low in-river survival during drought years.

Several comments were made on the draft version of this Opinion that the transport studies are biased in favor of the transport groups for several reasons. These include handling stress incurred by tagging the fish at Lower Granite Dam and the fact that the control group includes fish that passed through turbines, which decreases their survival. NOAA Fisheries notes that the issue of an adequate control group has arguments on both sides. A counter-argument is that the screen systems select for smaller fish, which generally have lower survival, so the use of non-detected fish as the standard to compare against transported fish could bias the result in the direction of in-river fish. The issue of providing a suitable control study group for transportation studies of wild fish has been debated for years. It has been determined that tagging at Lower Granite Dam is required to obtain a sufficient level of statistical precision. While recognizing that this debate is unresolved, NOAA Fisheries still believes in the exercise of its best professional judgment that transportation provides important survival benefits for salmon compared to in-river migration during certain times of the year. Accordingly, NOAA Fisheries is retaining transportation as part of the reference operation.

<u>5.2.1.1.2.1 - Juvenile Fish Transport Program for Spring Migrants</u>. The spring migrant transportation protocol used in the reference operation was as follows:

- When seasonal average flows at Lower Granite Dam are projected to be less than 70 kcfs, no spill would be provided at collector projects, and all fish collected would be transported. This flow equates to the lowest 15% of annual runoff conditions for the lower Snake River. This operation maximizes transportation during low-flow years. This flow threshold criterion is based on the lower range of the confidence interval at which optimal survival for spring chinook is calculated to occur (Williams *et al.* 2004). It is assumed that, below this seasonal flow, maximum survival would be achieved by maximizing transportation.

- When seasonal average flows at Lower Granite Dam are projected to range between 70 and 85 kcfs, spill would be provided at all lower Snake River projects until May 1 or until steelhead collections predominate for three consecutive days. After that date, spill would be terminated, and all non-study fish that are collected would be transported. The rationale for this operation is that transportation has shown a consistent benefit to spring chinook early in the season only during the lowest flow years, so they should remain in-river to the extent possible. Conversely, these flows will be near the low end of the estimated 95% confidence interval (CI) survival threshold for steelhead. This operation would provide in-river passage for spring chinook during April but would switch to a maximum transportation strategy for steelhead when they make up the majority of fish being collected.

- When seasonal average flows at Lower Granite Dam are projected to be in excess of 85 kcfs, various levels of 24-hour spill would be provided at all Snake River collector projects throughout the spring season. This operation is a "spread-the-risk" strategy. On a seasonal basis, only the fish that are collected are transported, while all fish that pass through spillways or turbines remain in-river.

- There would continue to be no juvenile fish transportation from McNary Dam during the spring in the reference operation.

Compared to past practice, the reference operation delays the date when most SR spring chinook and steelhead juvenile migrants are collected and transported until May 1 in the majority of years. This operation is based on current research information that indicates there is no consistent benefit provided from transportation during the month of April for wild juvenile SR spring chinook and steelhead (Williams *et al.* 2004). Although, on an average annual basis, transportation has not been shown to provide any increase in adult returns relative to wild fish that migrated in-river, recent data have shown that transport benefits improve later in the spring season (Williams *et al*. 2004; Anderson *et al*. 2004). Williams *et al.* (2004) noted that, in some years, transported fish had higher average annual returns than the in-river fish, but in some years lower. Hatchery-origin SR spring chinook have consistently shown a benefit from transport operations.

Balancing the potential benefits of transportation with the possible risks that this operation poses to long-term diversity of the Snake River ESUs is challenging. Providing both spill and transportation is a method to balance the potential risks that might arise from relying solely on transportation as a management tool. Spill reduces the percentage of fish transported and increases the survival of the fish migrating in-river. The reference operation provides spill through the month of April in years when the average seasonal flow at Lower Granite Dam is projected to be between 70 to 85 kcfs and terminates spill on May 1 during these relatively low runoff years. The 70 kcfs threshold was chosen to reflect a breakpoint below which in-river survival decreases for all spring juvenile migrants. This breakpoint may also be associated with increasing water temperatures, which usually occur during the month of May.

5.2.1.1.2.2 - Juvenile Fish Transport Program for Summer Migrants. For the summer transport operations in the reference operation, which primarily affect SR fall chinook salmon, the

reference operation consists of the same transport operation as that called for in the 2000 Biological Opinion (Appendix D), i.e., no spill at collector projects and all collected fish would be transported from Lower Granite, Little Goose, Lower Monumental, and McNary dams. Williams *et al.* (2004) states that "no empirical evidence exists to suggest that transportation either harms or helps fall chinook salmon." Thus, it is uncertain whether transport provides a benefit or a detriment for SR fall chinook. Given the uncertainty surrounding the effects of transportation, NOAA Fisheries exercised its best professional judgment in order to include transportation in the reference operation.

A significant consideration in favor of this summer transport strategy is that, for the past several years since the 2000 Biological Opinion was released, the region has experienced above-average adult returns of SR fall chinook under a strategy that maximizes transportation of juvenile SR fall chinook during the summer months. Without better information, a change to a strategy of leaving more fish in the river could either further improve or instead reduce the level of adult returns. The risk of a reduction in adult returns associated with leaving more fish in the river is less acceptable than the risk of failing to achieve even higher adult returns than the record numbers observed during the past four years.

Therefore, for the reference operation, NOAA Fisheries' transport strategy will be to use the same approach identified in the 2000 Biological Opinion, i.e., to maximize juvenile fish collection and transportation because of concerns about low in-river survival rates.[5]

Reviewers of the draft of this Opinion disagreed that a reference operation designed to maximize survival would therefore maximize transport, and they suggested that both the reference operation and the UPA should be based on a "spread-the-risk strategy" of spilling at collector projects so that a larger proportion of fish is left to migrate in the river. Following are more specific comments related to this issue and NOAA Fisheries' response.

Several commenters questioned the conclusion of Williams *et al.* (2004) that the efficacy of transportation vs. in-river migration is unknown. They stated that smolt-to-adult returns (SAR) of in-river fish are higher than those of transported fish, if only groups of in-river fish passing through certain routes are considered, or if only years in which there are statistically significant differences between transported and in-river groups are considered. However, the conclusion of Williams *et al.* (2004) is based on the same information reviewed by others, but it considers all available information, rather than selected observations, which results in the wide range of uncertainty described above.

Some commenters stated that NOAA Fisheries' decision to maximize transportation in the reference operation was based only on consideration of effects on abundance and overlooked effects on other VSP characteristics, such as life history diversity. One reviewer contended that maximizing transportation artificially suppresses biological adaptations, such as new rearing and outmigration strategies, but supporting evidence was not offered for this claim. Williams *et al.*

[5] As part of the UPA, the Action Agencies have proposed to initiate an in-river survival and summer transport evaluation in the Snake River. This evaluation should resolve some of the uncertainties surrounding the benefits of transportation.

(2004), cited by one reviewer, stated that "fish spillways, the use of transportation, flow augmentation, and other management strategies may select for particular stocks or life histories and could therefore reduce diversity if used exclusively." Williams *et al.* (2004) concurred with the general recommendation of ISAB (1998) to "[spread] the risk of negative outcomes among alternative routes of hydroelectric passage" in the face of uncertainty, such as "potential negative effects of transportation on genetic and life history diversity."

When choosing among alternative actions, the risk and uncertainty associated with each alternative must be taken into consideration. The effects of maximizing transportation on genetic and life history diversity are largely speculative at this point. No evidence of specific genetic or phenotypic effects of transportation on Snake River fall chinook (or other ESUs) is presented in any of the comments, in ISAB (1998), or in Williams *et al*. (2004). In contrast, the high mortality associated with in-river migration to Bonneville Dam is well known, as are the high recent adult returns, which occurred during a period of maximum transportation operations. Clearly, additional information on genetic and phenotypic effects of both transport and in-river migration would be useful. But available information regarding the possible effects of transportation on diversity does not currently outweigh the rationale cited above for specifying the 2000 Biological Opinion transportation program as the reference operation.

Several commenters stated that, given the uncertainty, the appropriate management response should be to "spread the risk" in order to avoid possible catastrophes that would only affect transported fish and to avoid putting "all of the eggs in one basket." It is difficult to envision a catastrophe that would significantly affect transported fish. Emergency procedures are specified in the Fish Passage Plan for problems associated with bypasses and holding facilities at each project. If an emergency necessitated returning most fish to the river at a particular project, it is likely that in-season management would adjust operations on an emergency basis to provide safer in-river passage conditions. Because transportation occurs at four projects and extends over a 4-month period, localized emergencies would be unlikely to significantly impact the ESU.

One commenter indicated that RPA Action 51 in the 2000 Biological Opinion required that in-river conditions at collector dams must be optimized if results of transport studies indicate no difference between survival of in-river and transported fish. However, the intent of RPA Action 51 was to review information of valid studies and plan to "identify and implement appropriate measures to optimize in-river passage" if those studies indicated transport was not providing any benefit. The pertinent example used in the FCRPS 2000 Biological Opinion referenced spring/summer chinook transport studies which have been conducted for nearly 30 years. However, in the case of fall chinook, the results of the first valid transport study are not yet available. The information currently available for fall chinook is preliminary and highly uncertain. This is reflected in the text of the Fish Passage Center's analysis of the transportation of fall chinook smolts (FPC 2004) cited by several commenters. The analysis noted, "Because the goals of these PIT tag studies required keeping the fish in-river, there were low numbers of PIT tagged subyearling chinook routed to transportation until 2001 when NMFS began a multi-year transport evaluation." The referenced analysis was not based on a study plan designed to evaluate the issue of transport benefits. Likewise, the analysis conducted by NOAA Fisheries' NWFSC was based on the same preliminary analysis of available data. Williams *et al.* (2004) concluded, "Preliminarily, our analyses suggest that transportation appeared to neither greatly

harm nor help the fish." The value of the preliminary conclusions based solely on PIT tag returns was questioned by Connor (2004), who noted:

> Our finding that a significant number of returning spawners exhibit a reservoir-type life history as juveniles has important implications for studies examining the efficacy of transportation. It is likely that assumptions of ongoing transportation studies are violated and results will be misleading if juvenile fish spend their first winter in a reservoir. Comparing smolt-to-adult return rates of ocean-type juveniles that were transported to the smolt-to-adult return of reservoir-type juveniles that migrated in river will provide misleading results with respect to the efficacy of transportation. (Connor 2004)

Thus the validity of these preliminary conclusions is suspect.

As indicated, Connor *et al*. (2004) found that a significant number of the returning SR fall chinook adults had actually over-wintered somewhere within the system and emigrated to the ocean as larger yearlings. Referring to this study, one commenter stated that a spread-the-risk operation is appropriate, claiming that transportation offers no advantage and purportedly a likely disadvantage to these fish. Connor (2004) concluded that "Summer flow augmentation provides the highest level of protection for later migrating fall Chinook salmon juveniles that are most likely to exhibit this reservoir-type juvenile life history." No one knows for certain where these "reservoir-type" fall chinook over-winter. Given that these reservoir-type fall chinook migrated without detection, it is quite possible that they were migrating downstream over the winter (when the detection devices are not being operated) rather than in the summer. If so, changing flow regimes in the summer or making other summer operational changes would be of little benefit. Given the uncertainty associated with the findings and the significant possibility that these "reservoir-type" fish are unlikely to be migrating unseen in the late summer, NOAA Fisheries deemed it unwise to risk harm to the current above-average adult returns by forgoing transportation in order improve in-river conditions at a time when the "reservoir-type" fish may not even be present.

5.2.2 Effects of the Existence of the FCRPS and Non-discretionary Operations

This section describes the Federal Columbia River Power System (FCRPS) and other hydroelectric development in the Columbia River basin and analyzes their effects on the survival of anadromous fish. Resulting habitat conditions relevant to multiple ESUs are discussed in Section 5.2.2.1. Effects specific to individual ESUs are discussed by species in Section 5.4. Effects on juvenile and adult survival relevant to multiple species are discussed in Section 5.2.2.2, while effects specific to individual ESUs are discussed by species in Section 5.4. NOAA Fisheries' analytical approach and methods for evaluating juvenile and adult survival are described in Appendix D and are summarized in Sections 5.2.2.3.1.1 and 5.2.2.3.3.

5.2.2.1 Effects of the FCRPS on Habitat Conditions Affecting Multiple ESUs

5.2.2.1.1 Historical Effects of the FCRPS on Habitat Conditions Affecting Multiple ESUs. The FCRPS is a system of water resource projects built within the Columbia River basin. These

Federal projects were developed over a 37-year period, starting with Bonneville Dam in 1938 and Grand Coulee Dam in 1941 and ending with construction of Libby Dam in 1973 and Lower Granite Dam in 1975. A series of large storage dams in the headwaters of the basin (both in the U.S. and Canada) hold back heavy spring and summer snowmelt runoffs to prevent flooding. In the winter, when stream flows would ordinarily be low, water is gradually released from the storage reservoirs. The water flows through downstream run-of-the-river dams in the Snake and Columbia rivers and provides such other river uses as fish migration, navigation, irrigation, recreation, water supplies to industrial and municipal users, water quality, and power generation. FCRPS annual operations are planned, coordinated, and implemented through a number of treaties, Federal laws, and operating agreements to achieve the multiple purposes for which the projects were built.

Concern over the decline of salmon and steelhead species and the effects of the FCRPS surfaced in the 1960s and 1970s, and voluntary efforts to improve fish survival were initiated. The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Act) provided the first structured institutional means to restore and protect fish populations in the basin. The Act established a regional body now referred to as the Northwest Power and Conservation Council, which is responsible for developing a regional fish and wildlife program that included changes in how the FCRPS was operated. The most notable was the establishment of an annual water budget, which enabled salmon managers to call for the release of limited amounts of water from storage projects in the upper Columbia and Snake rivers to aid the spring downstream migration of juvenile salmon. The program also contained non-hydrosystem strategies for improving fish and wildlife.

Development of the Pacific Northwest regional hydroelectric power system, dating to the early twentieth century, has had profound effects on the ecosystems of the Columbia River basin (ISG 1996). These effects have been especially adverse to the survival of anadromous salmonids. The direct effects of the construction of the FCRPS on salmon and steelhead in the Columbia basin can be divided into four categories: blockage of habitat; alteration of habitat; barrier to, or modification of, juvenile migration; and barrier to, or modification of, adult migration. Where no fish passage facilities have been provided, hydroelectric dams completely block anadromous fish runs on the river. In addition, dams inundate historical spawning and rearing habitat. For salmon and steelhead, much of this effect occurred with Federal construction of Grand Coulee (1941) and Chief Joseph (1961) dams on the Columbia River and the privately-developed Hells Canyon Hydroelectric Complex (1959) on the Snake River. More than 55% of the Columbia River basin accessible to salmon and steelhead before about 1939 has been blocked by large dams (NWPPC 1986).

The eight FCRPS dams in the migration corridor of the mainstem Snake and Columbia rivers have altered both juvenile and adult fish migrations. Dams present barriers to the upstream and downstream migrations of anadromous fish, and a substantial rate of juvenile injury and mortality occurs during downstream passage. Physical injury and direct mortality result from passage through turbines, juvenile fish bypasses, and, to a lesser degree, spill. Indirect effects of passage through all routes may include disorientation, stress, delay in passage, exposure to high concentrations of dissolved gases, exposure to warm water, and cumulative effects of all of the above. Although the direct mortality of adults is low during passage at individual dams, each

dam presents the potential for delays at fishway facilities, energy expenditure in passage through multiple fishways, involuntary fallback, downstream passage difficulties for iteroparous fish (e.g., steelhead), and, during periods of involuntary spill, increased exposure to high concentrations of dissolved gases.

The impoundments created by the FCRPS dams greatly increased the cross-sectional area in much of the Columbia and lower Snake rivers, reducing water velocity and water particle travel times in the impounded river reaches. Past and present water regulation activities in upriver storage reservoirs has modified the natural hydrograph and affected the listed species throughout the action area, from the up-river storage reservoirs to the Columbia River plume. Water regulation and upstream water development has reduced flow (volume per unit time) to less than what would naturally occur during runoff of snowmelt in spring and early summer.

Water regulation and impoundment has also changed water quality factors such as temperature and turbidity, as well as the production of salmonid prey, since reservoirs also provide habitat for salmonid predators. The construction of multiple hydroelectric projects on the mainstem Columbia and Snake rivers created a series of reservoirs with markedly reduced water velocities. Slackened river flows in the reservoirs allow sediments to settle, altering water clarity, and augmenting solar and meteorological influences on water temperature. Channel complexity has been reduced, affecting fluid dynamics (e.g., ISG 1996) and substrate types. Load-following operations at hydrosystem projects (hourly and daily changes in project discharge to meet prevailing electrical loads and reduced weekend flows) can affect access to suitable spawning habitat and can trap and strand both adults and juveniles.

NOAA Fisheries placed the first Pacific Northwest salmon ESU on the endangered species list in 1991. Since then, NOAA Fisheries and the FCRPS Action Agencies have engaged in numerous consultations on how to enhance the migration of listed endangered salmon and steelhead through the FCRPS. Biological opinions outlining a number of proposed operations and structural configuration changes to FCRPS dams were issued in 1993, 1994, 1995, 1998, and 2000. As a result of these operations and configuration improvements, juvenile and adult survival through the FCRPS migration corridor has improved significantly since the early 1990s. For Snake River spring/summer chinook juveniles migrating in-river, Williams *et al.* (2004) estimated survival through the eight mainstem Federal dams is now between 28% and 58%, compared with an estimated survival rate during the 1970s of 3% to 30% (Williams *et al.* 2001). For Snake River steelhead juveniles migrating in-river, Williams *et al.* (2004) estimated survival through the eight mainstem Federal dams to currently range between 4% and 50%, compared with an estimated survival rate during the 1970s of 1% to 27% (Williams *et al.* 2001). The transportation of smolts from the Snake River and McNary Dam on the Columbia River has also improved passage survival rates.

5.2.2.2 Hydrologic Effects

5.2.2.2.1 Differences between the Reference Operation and Historical Hydrologic Effects

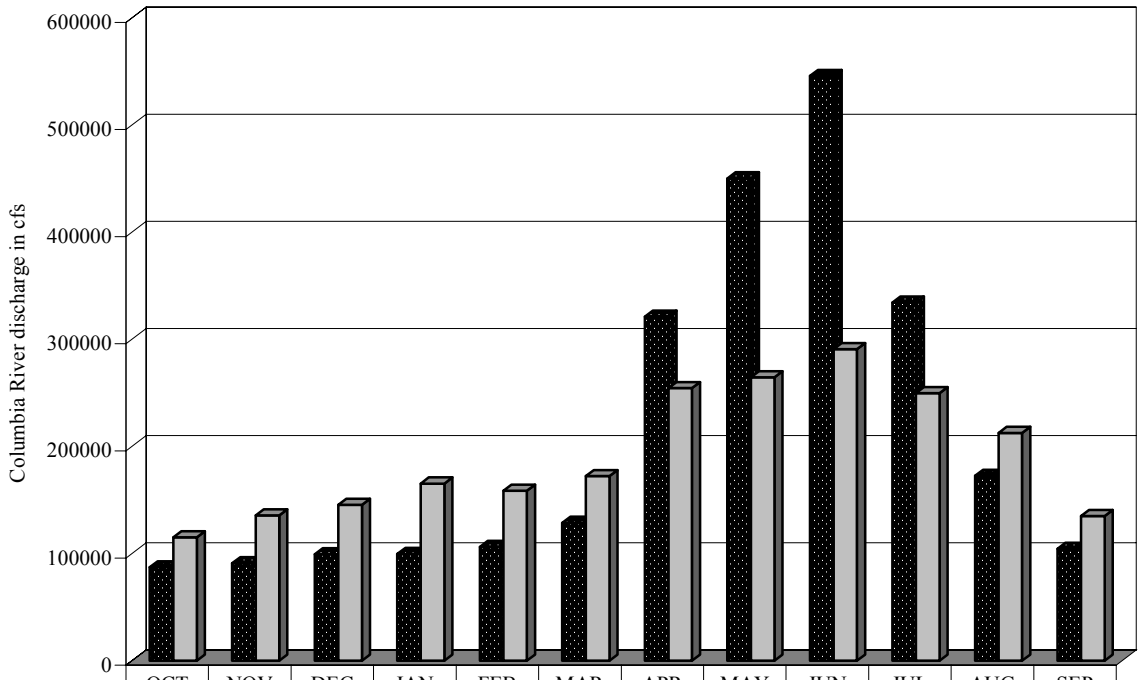
Large multipurpose storage projects developed in both Canada and the United States have altered the seasonal runoff pattern and volume of flow throughout the mainstem corridor and into the estuary. Model studies by Bottom *et al.* (2001) indicate that the volume and timing of water and

sediment delivery have changed in the Columbia River basin since the late 1880s due to the hydrosystem operation, even after the effects of climate change and irrigation withdrawals are taken into account. Compared with hydrologic conditions in the 1880s, reference operations with the FCRPS dams and reservoirs in place result in the following effects:

- Deliver more water to the estuary during winter (October through April) and less water during the spring freshet in late spring and early summer (May through July).
- Reduce the peak spring freshet by more than 40% and reduce total freshet-season flow volume by about 30%.
- Lengthen the period of the freshet and move the peak flow earlier (by pre-releasing stored water for total dissolved gas control.
- Greatly increase fall-winter minimum flows.

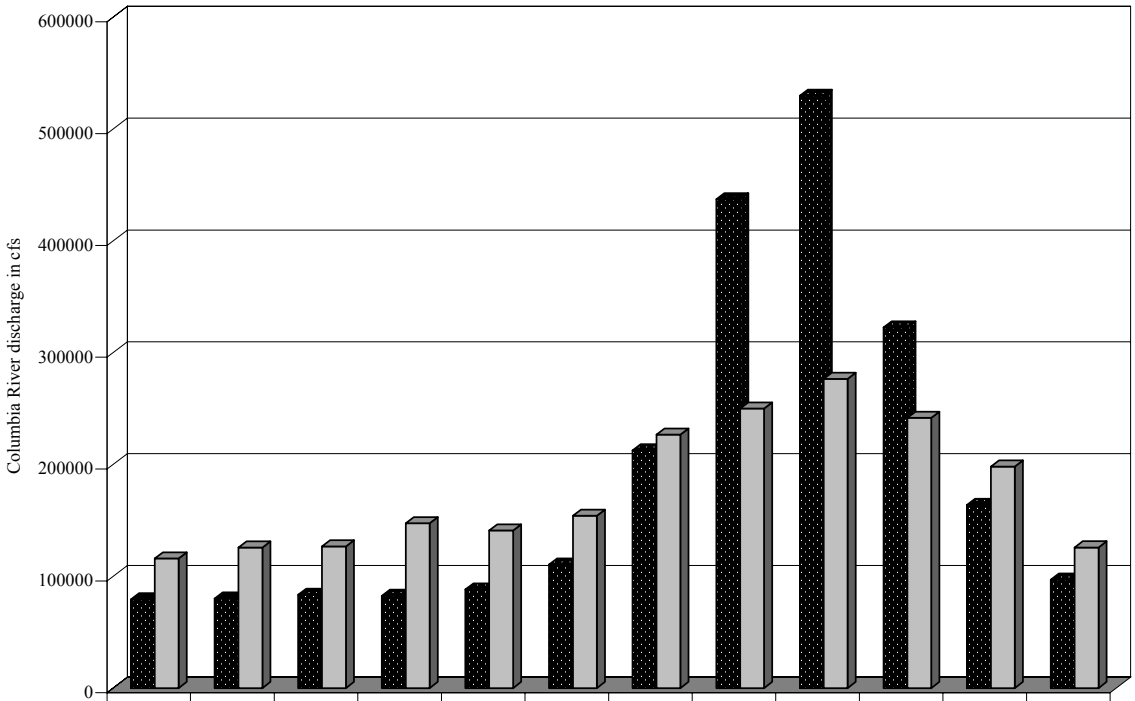
These hydrologic effects are illustrated by Figures 5.2 through 5.4, which depict simulated hydrologic conditions under both the reference operation and conditions that would have existed in the absence of water and hydropower developments.

Figure 5.2. Mean monthly Columbia River discharge (cfs) at Bonneville Dam under pre-development natural flows and under the reference operation. Sources: Natural Flows, USBR 1999; Reference Operation, BPA HYDSIM Model run 03FSH05D9 dated 8-10-04.



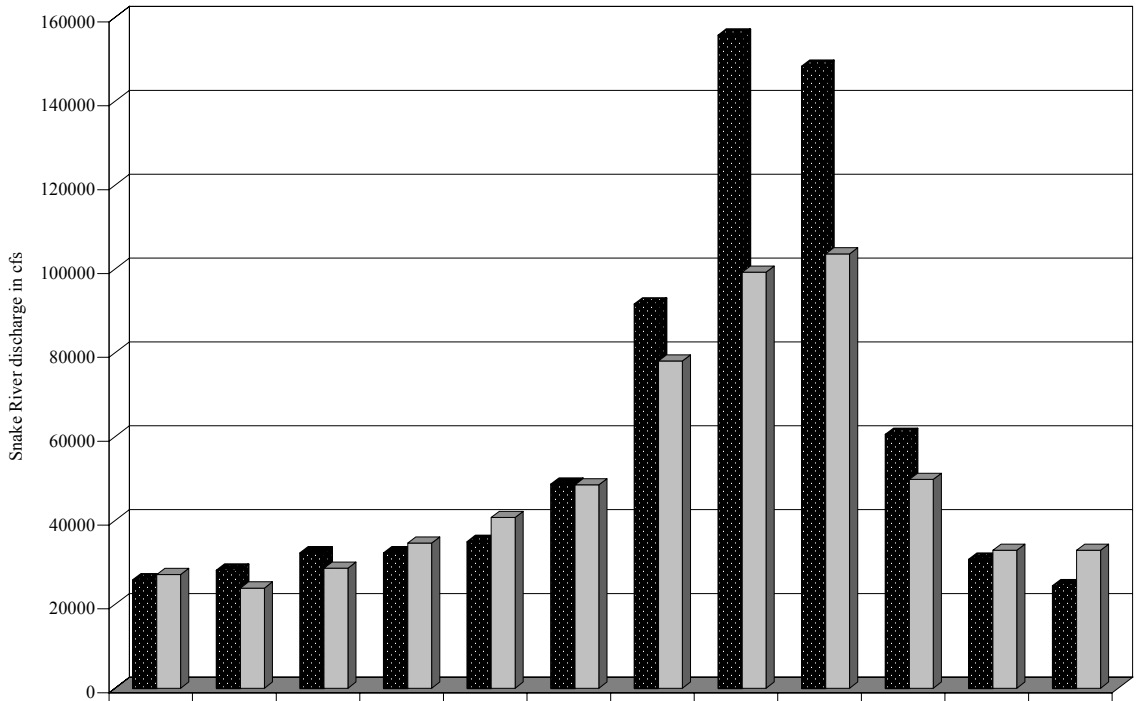
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Natural Flows	87100	91000	99400	99500	106000	128600	321000	450000	545600	334200	172400	104300
Reference Operation	115000	135700	145400	165200	158500	172200	254300	264400	290500	249500	212500	135000

Figure 5.3. Mean monthly Columbia River discharge (cfs) at McNary Dam under pre-development natural flows and under the reference operation. Sources: Natural Flows, USBR 1999; Reference Operation, BPA HYDSIM Model run 03FSH05D9 dated 8-10-04.



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Natural Flows	79400	80000	83500	82500	88200	110400	212600	437200	529700	322500	163900	97007
Reference Operation	115900	125700	126700	147400	141000	154000	226600	249900	276600	241700	198100	125787

Figure 5.4. Mean monthly Snake River discharge (cfs) at Lower Granite Dam under pre-development natural flows and under the reference operation. Sources: Natural Flows, USBR 1999; Reference Operation, BPA HYDSIM Model run 03FSH05D9 dated 8-10-04.



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Natural Flows	25800	28100	32200	32200	34900	48600	91600	155700	148300	60500	30700	24400
Reference Operation	27100	23900	28600	34600	40700	48500	78000	99200	103600	49800	32900	32900

5.2.2.2.2 Historical Effects on Habitat in Columbia River Mainstem, Estuary, and Plume. The lower Columbia River and estuary habitats have been affected over the past 60 years by the series of mainstem hydrosystem reservoirs and by the operation of upstream multipurpose storage projects. The impoundments have also inundated extensive salmon spawning and rearing habitat. Historically, fall chinook salmon spawned in mainstem reaches from near The Dalles, Oregon upstream to the Pend Oreille and Kootenai rivers in Idaho and to the Snake River downstream of Shoshone Falls. Presently, mainstem production areas for fall chinook are confined to the Hanford Reach of the Columbia River, the Hells Canyon Reach of the Snake River, the mid-Columbia River, and in the tailrace areas below the lower Snake River projects and below Bonneville Dam. The Hanford Reach is the only known mainstem spawning area for steelhead. Spawning habitat used historically by LCR chinook, CR chum salmon, and by LCR steelhead was probably inundated by the Bonneville pool, as well.

The mainstem habitats of the lower Columbia and Willamette rivers have been reduced primarily to a single channel. Floodplains have been reduced, off-channel habitat features have been eliminated or disconnected from the main channel, and the amount of large woody debris in the mainstem has been greatly reduced. Finally, most of the remaining habitats are affected by flow fluctuations associated with reservoir water management for power peaking, flood control, irrigation, and other operations.

In addition, model studies indicate that the hydrosystem and climate change together have decreased suspended particulate matter to the lower river and estuary by about 40% (as measured at Vancouver, Washington) and have reduced fine sediment transport by 50% or more (Bottom *et al.* 2001). Overbank flow events, important to habitat diversity, have become rare, in part because flow management and irrigation withdrawals prevent high flows and in part because diking and revetments have increased the "bank full" flow level (from about 18,000 to 24,000 m^3/s). The dynamics of estuarine habitat have changed in other ways relative to flow. The availability of shallow (between 10 cm and 2 m depth), low-velocity (less than 30 cm/s) habitat now appears to decrease at a steeper rate with increasing flow than during the 1880s, and the absorption capacity of the estuary appears to have declined.

The significance of these changes for salmonids is unclear. Estuarine habitat is likely to provide services (food and refuge from predators) to subyearling migrants that reside in estuaries for up to two months or more (Casillas 1999). Historical data from Rich (1920) indicate that small juvenile salmon (< 50 mm), which entered the Columbia River estuary during May, grew 50 to 100 mm during June, July, and August. Data from a more contemporary period (Dawley *et al.* 1986; CREDDP 1980) show neither small juveniles entering the estuary in May nor growth over the summer season.

The Columbia River plume also appears to be an important habitat for juvenile salmonids, particularly during the first month or two of ocean residence. The plume may simply represent an extension of the estuarine habitat. More likely, it represents a unique habitat created by interaction of the Columbia River freshwater flow with the California Current and local oceanographic conditions. Ongoing studies show that nutrient concentrations in the plume are similar to nutrient concentrations associated with upwelled waters. Upwelling is a well recognized, oceanographic process that produces highly productive areas for fish. Primary productivity, and more important, the abundance of zooplankton prey, is higher in the plume compared with adjacent non-plume waters. Further, salmon appear to prefer low surface salinity, as the abundance and distribution of juvenile salmon are higher and more concentrated in the Columbia River plume than in adjacent, more saline waters. These findings support the notion that the plume is an important habitat for juvenile salmonids. What is not known is how Columbia River flows affect the structure of the plume during outmigration periods and whether critical threshold flows are needed.

5.2.2.2.3 Differences between Reference Operation and Historical Effects on Habitat in Columbia River Mainstem, Estuary, and Plume

Most of the effects described above also apply to the reference operation. However, because reference operation flows are slightly lower during the fall and winter, higher during the summer, and relatively unchanged during the spring, when compared with recent hydrologic effects, some of the habitat effects would differ. These differences would include less mainstem spawning habitat for SR fall chinook, LCR fall chinook, and CR chum salmon. In the lower Snake River, the effect of higher summer flows could be to increase subyearling chinook survival compared to recent conditions (see Appendix D). There is no empirical data on the survival of subyearling chinook as a function of flow in the lower Columbia River, but the difference between the

reference operation and recent conditions could be similar to that in the lower Snake (i.e., improved with the higher flows under the reference operation).

5.2.2.3 Effects of the FCRPS Reference Operation on Juvenile and Adult Survival Rates Affecting Multiple ESUs

5.2.2.3.1 Effects on Juvenile Salmonid Passage Survival

5.2.2.3.1.1 - Methods Used to Estimate Juvenile Survival Rates. Methods of estimating juvenile survival associated with the reference operation are detailed in Appendix D. Briefly, the SIMPAS passage model was calibrated to empirical reach survival estimates for Snake River spring/summer chinook salmon (1994-2003), Snake River steelhead (1994-2003), and Snake River fall chinook salmon (1995-2001 and 2003). Various project operations, such as spill levels and MOP operations, as well as dam passage parameters in the model were adjusted to simulate the effect the reference operation would have had on juvenile survival under each of those annual conditions. Survival of additional ESUs was inferred from the passage of the three modeled ESUs through the appropriate mainstem projects. While all assumptions and methods are detailed in Appendix D, a few of the more important ones are described here.

- Relation Between Flow and Reservoir Survival
  Project reservoirs increase the time required for juvenile migration. This delay affects survival by increasing the time the fish are exposed to mortality vectors (e.g., disease, predators, adverse water temperatures); disrupting their time of arrival in the estuary (i.e., estuary arrival timing may affect predator/prey relationships and other environmental conditions); depleting energy reserves; and, for steelhead, delay has been shown to cause residualism (a loss of migratory behavior). A substantial percentage of the mortality experienced by juvenile outmigrants through the portion of the migratory corridor affected by the FCRPS occurs in the reservoirs (e.g., about half of juvenile fall chinook mortality occurs in the reservoirs), so reducing migration delays is a focus of past and present actions to improve juvenile outmigrant survival through the FCRPS.

  The SIMPAS model includes a relationship between annual survival and annual average flow rates for all three ESUs that are directly modeled. The relationships for SR spring/summer chinook salmon and SR steelhead are based on empirical survival rates through the entire FCRPS. For SR fall chinook salmon, the relationship is based on empirical reach survival rates through the four lower Snake River projects, but empirical reach survival rates are not available through the lower Columbia River projects. The model was therefore run under two sensitivity analyses. Under the first, the empirical reach survival estimates from the lower Snake River were extrapolated to the lower Columbia River using methods described in Appendix D. It is possible that this method over-estimates reservoir mortality in the lower Columbia River, because PIT-tagged SR fall chinook salmon have a much faster migration rate through the lower Columbia than through the Snake River, so they may experience less exposure to predation. Under the second sensitivity analysis, flow is estimated to have no effect on reservoir survival rate in the lower Columbia River. This analysis may under-estimate the mortality rate under lower flow conditions. The two sensitivity analyses are expected to largely bound the

range of reservoir survival rates for SR fall chinook salmon. These sensitivity analyses are only applied to the relative differences in survival discussed in Section 6.0.

- Dam Passage Parameters

  Dam passage parameters were estimated from a review of the literature, including summaries in Ferguson *et al.* (2004). These parameters are important because dams impede the safe passage of juveniles. Some juvenile mortality is associated with all routes of passage at dams, but turbines cause the highest direct mortality (Whitney *et al.* 1997), and use of spillways results in the lowest direct mortality (NMFS 2000d). Some passage routes have additional effects, such as the increase in TDG (total dissolved gas) caused by spill. In general, higher dam passage survival occurs when a high proportion of juveniles are routed past the projects in a manner that avoids passing them through turbines. The proportion of smolts that pass a project through either bypass systems or spillways, also described as project fish passage efficiency (FPE), varies by species composition and may vary within a season and between years for a single species with changes in smolt condition, environmental conditions, and project operations.

  Reviewers of the draft Biological Opinion expressed a concern that the analysis failed to address several water quality factors and did not evaluate the effects of these factors on juvenile salmon. Although it might be desirable to address various sources of lethal or sublethal stress due to water quality factors on juvenile migrants, it is difficult to do so. The basic effects information may not be available, or the quality of current information may be inadequate to conduct an analysis. In the cases of multiple factors acting in concert, salmonid responses may not have been previously investigated and reported. Moreover, the anticipated differences in water quality factors, e.g., turbidity, sediment transport, nutrient cycling, or pesticide exposure, between the UPA and reference cases were considered to be negligible.

- Survival of Transported Fish

  Fish placed on barges are assumed to have a 98% survival rate to the point of release. In the analyses of ESUs that are transported from collector projects, the survival rate of transported fish is adjusted by estimates of the differential survival rate of transported fish, compared to in-river migrants, below Bonneville Dam. This ratio (referred to as "D") essentially adjusts transported and non-transported juveniles to Bonneville Dam equivalents. Empirical estimates of D in Williams *et al.* (2004) were applied to SR spring/summer chinook salmon and SR steelhead. Mean estimates based on a range of water years were applied.

  Corresponding estimates for SR fall chinook are not available. Williams *et al.* (2004) suggested that, based on the range of smolt-to-adult returns (SAR) for a few relatively small groups of transported and non-transported fish in recent years, the D-value might range between 0.67 and 1.50 times the in-river survival rate. The in-river survival rate in question is that of non-transported fish from the tailrace of the collector project to the tailrace of Bonneville Dam.

Under the simplifying assumption that all transported fish are collected at Lower Granite Dam, the in-river survival rate below this point under recent conditions ranges from approximately 17-43%, depending upon water year (Appendix D, Attachment 5). If transportation from other sites were considered, the in-river survival rate would be higher (since there would be fewer downstream dams and reservoirs to pass), as would the estimated D, so this approach is conservative. When those in-river survival rates are multiplied by the low estimate of 0.67 from Williams *et al.* (2004), the resulting range of D-values is 11 to 22%, with a mean value of 18% (Appendix D, Attachment 5). When the survival rates are multiplied by the high estimate of 1.5 from Williams *et al.* (2004), the resulting range of D-values is 25 to 50%, with a mean value of 41% (Appendix D, Attachment 5).

Because the uncertainty associated with SR fall chinook D-values is great, NOAA did not report absolute estimates of system survival (including D) for this ESU for the reference or proposed operations. However, a sensitivity analysis using the range of likely D-values was applied to the relative difference between operations in Section 6. Details are included in Appendix D, Attachment 5. For this sensitivity analysis, D = 18% to D = 41% was analyzed, since these bounds represented the mean estimates over a range of water years, for both the low and high multipliers defined in Williams *et al.* (2004).

- Calculation of In-River Survival Rates for ESUs That Are Transported and Estimation of Abundance for SR Fall Chinook

  In-river survival rates were estimated for all three Snake River ESUs using the SIMPAS model. These survival rates were estimated by modeling an operation without transportation from collector projects, but with all other factors identical. These survival rates only apply to the small fraction of fish that migrates entirely in the river under the reference operation (and under the proposed action analyzed in Chapter 6).

  The survival rate of transported SR fall chinook salmon is highly uncertain, as described above, so only estimates of the in-river survival rate are presented for the reference and proposed operations. Estimates of the proportion of fish transported and their survival rate is required to properly determine the weight that should be placed on differences in in-river survival between alternative operations for this ESU. However, one way to put the effect of differences in in-river survival into perspective is to evaluate the number of in-river fish that are affected. This is relevant, because the alternative operations under consideration do not change the transport operation or numbers of transported fish survivors (regardless of D), as described in Appendix D. The number of in-river fish was calculated for SR fall chinook by modeling the transportation operation and determining the percentage of fish arriving below Bonneville Dam as in-river migrants. For convenience, this was presented as the number per 1000 juveniles arriving at the head of Lower Granite Reservoir and as the number per two million smolts arriving at the head of Lower Granite Reservoir. The second characterization is a very rough approximation of the number of fish that may be arriving at Lower Granite Reservoir in a given year.

- Consideration of Alternative Life History Strategies for SR Fall Chinook

  Recent evidence suggests that SR fall chinook salmon follow both a subyearling and yearling migration strategy (Connor *et al.* 2004). The SIMPAS model analysis considered only the subyearling life history phase for SR fall chinook and did not include in the analysis any additional survival that would be afforded the yearling life history. The survival of the yearling phase of SR fall chinook would likely be much higher, because they would migrate at a larger size and under cooler water conditions during the fall, winter or early spring of the following year. Accordingly, their survival rates would likely be closer to that of yearling SR spring/summer chinook. The proportion of fish that migrate as prospective yearlings is unknown, so a sensitivity analysis to evaluate the impact of various proportions of yearling migrants was conducted and applied to the differences in operations described in Section 6.0.

- Latent Mortality of In-river Migrants

  NOAA Fisheries received several comments on the September 2004 draft of this Opinion noting that NOAA Fisheries did not take into account latent mortality of in-river fish in the baseline or reference condition effects. Most reviewers cited an updated estimate of delayed mortality of 81% for brood years 1991-1998, which was based on the PATH "delta model" and reported in a Comparative Survival Study Workshop report (Marmorek *et al.* 2004). This estimate was based on differential productivity between spring/summer chinook from the Snake River and John Day River basins. Williams *et al.* (2004) questioned the validity of concluding that latent mortality exists and making estimates of the magnitude of latent mortality based on stocks from very different river basins. Nonetheless, in reviewing ongoing scientific debate on this issue (e.g., Schaller *et al.* 1999; Zabel and Williams 2002), Williams *et al.* (2004) considered several possible alternative hypotheses for mechanisms leading to latent mortality and concluded that, "Clearly some level of latent mortality exists," noting that, for in-river migrants, hydropower system-related latent mortality ranges somewhere from very weak to potentially strong. Further, NOAA Fisheries has little data at present by which to discern among this broad range of possibilities.

  In this Opinion, it is not necessary to estimate overall hydrosystem-related latent mortality unless it differs between the reference and proposed operations. The relevant consideration in NOAA Fisheries' survival analysis is the change in latent mortality associated with various dam operations. NOAA Fisheries submits that most of the hypothesized causes of latent mortality would be present under both the reference and proposed action operations, since they are related to the existence of the dams. NOAA Fisheries has attempted to estimate the effect of operating the FCRPS projects by maximizing spill and flow to the extent possible and thereby reducing travel time of the fish through the projects. Those differences in survival are considered in the survival gap analysis, which reflects differences in direct mortality. Latent mortality would be the difference in post-Bonneville mortality that would be attributable to the percentage of juvenile fish passing through spillways rather than bypasses or turbines and from fish arriving to the estuary earlier in the season. At present, it is uncertain whether different

passage routes result in different levels of latent mortality (Williams *et al.* 2004) or, if they do, what the magnitude of the effect might be. No suggestions for resolving this uncertainty were provided in any of the comments on the September 2004 draft of this Opinion, and NOAA Fisheries did not perform any quantitative estimate of this potential effect in this Opinion. However, NOAA Fisheries acknowledges that there could be some difference between the reference and proposed operations in post-Bonneville mortality that is not otherwise captured in other aspects of the analysis. To account for this possibility, NOAA Fisheries conservatively evaluated offsetting actions to be sure that the conclusions would not change if some additional post-Bonneville impact was included.

5.2.2.3.1.2 - Juvenile Survival Estimates. Juvenile survival estimates for ESUs passing through one or more FCRPS projects under the reference operation are presented in Table 5.1. Clearly, juvenile mortality is associated with the existence of dams and reservoirs in the FCRPS, even when operated according to the reference operation. It is difficult to interpret the significance of this mortality without also knowing something about the mortality that would likely occur if the dams and reservoirs were not in place. To inform this issue, NOAA Fisheries made some simplistic estimates of the rate of mortality that might occur if the reservoirs and dams were not present and presented the resulting estimates in Table 5.1. The methods used were similar to those included in Annex 1 of Appendix A of the 2000 FCRPS Biological Opinion, which relied upon extrapolation of survival rates through free-flowing reaches of the Snake River to the length of the Snake and Columbia rivers traversed by listed ESUs (Ferguson 2004). Data used in the 2000 FCRPS Biological Opinion were updated to include more recent survival estimates.

This comparison suggests that a non-trivial level of mortality would likely occur even under free-flowing river conditions. .Although there is a high level of uncertainty associated with the extrapolation of limited data for free-flowing survival estimates, the existence and operations of the dams and reservoirs nevertheless account for most of the mortality of juvenile migration through the FCRPS if the mean values for the free-flowing river survival estimates are approximately correct.

Table 5.1. Estimated average juvenile survival rates over 1994-2003 study period through the FCRPS under the reference operation and free-flowing river conditions. These estimates do not include possible post-Bonneville latent mortality of in-river migrants (Section 5.2.2.3.1.1).

ESU	Estimated Juvenile In-river Survival Rate	Estimated Juvenile System Survival Rate (including transport latent effects)	Estimated Free-Flowing River Survival Rate
SR Spring/Summer Chinook Salmon[a]	54.1% (42.2% to 59.3%)	52.5% (50.7% to 53.9%)	78.6%
SR Fall Chinook Salmon[a,g]	17.0% (9.8% to 23.6%) 7.9 in-river fish per 1000 @ LGR pool alive below BON (3.4-14.2)	N/A	50.8%
UCR Spring Chinook Salmon	71.4% (60.2% to 76.9%)	N/A	85.5%
LCR Chinook:			
Gorge Fall MPGs[b]	88.4% (79.8% to 97.6%)	N/A	95.5%
Gorge Spring MPGs[c]	91.4% (87.1% to 94.0%)	N/A	98.4%
Below BON Dam MPGs	N/A	N/A	N/A
UWR Chinook Salmon	N/A	N/A	N/A
SR Steelhead[a]	34.1% (6.2% to 47.0%)	49.5% (42.8% to 53.6%)	82.1%
UCR Steelhead	51.4% (20.6% to 66.9%)	N/A	87.9%
MCR Steelhead:[d]			
Passing MCN-BON	51.4% (20.6% to 66.9%)	N/A	88.9%
Passing JDA-BON	60.1% (32.1% to 77.2%)	N/A	91.5%
From JDA Dam-BON	73.0% (44.0% to 90.4%)	N/A	95.6%
Passing TDA-BON	75.3% (45.3% to 93.1%)	N/A	96.4%
Passing BON Dam	86.2% (65.1% to 97.1%)	N/A	99.1%
LCR Steelhead:[e]			
Passing BON Dam	86.2% (65.1% to 97.1%)	N/A	99.1%
Below BON Dam	N/A	N/A	N/A
UWR Steelhead	N/A	N/A	N/A
CR Chum	N/A	N/A	N/A
SR Sockeye	N/A	N/A	N/A
LCR Coho[f]	91.4% (87.1% to 94.0%)	N/A	95.5%

[a] The estimated juvenile survival rates shown in this table for transported ESUs are only for those fish that remain in-river for their entire juvenile migration and are not transported.
[b] Estimated juvenile survival rates for LCR (fall) chinook salmon are based on per-project survival rate of SR fall chinook salmon.
[c] Estimated juvenile survival rates for LCR (spring) chinook salmon are based on per-project survival rate of SR spring/summer chinook salmon.
[d] Estimated juvenile survival rates for MCR steelhead are based on per-project survival rate of SR steelhead.
[e] Estimated juvenile survival rates for LCR steelhead are based on per-project survival rate of SR steelhead.
[f] Estimated juvenile survival rates for LCR coho salmon are based on per-project survival rate of SR spring chinook salmon.
g Applies only to subyearling life history strategy. An unknown proportion of fish with yearling strategy will have survival rates more closely resembling those of SR spring/summer chinook.

5.2.2.3.2 Effects on Adult Salmonid Passage Survival. Adult salmon and steelhead must pass up to eight mainstem dams and reservoirs to reach their natal spawning streams and river reaches. Each FCRPS project within currently occupied habitats imposes stresses on migrating adults. Those project-induced effects most likely to adversely affect adult survival are: delay and delay-induced predation, water quality changes (e.g., total dissolved gas concentrations and water temperatures), and fallback and volitional downstream passage (e.g., kelts).

To pass each dam, adult fish must successfully locate and ascend the project fish ladder(s). The ability to successfully pass each dam has been found to be affected by project configuration and various operating characteristics, principally attraction flow rates, project spill patterns, and powerhouse discharge patterns. However, Bjornn *et al.* (2000) estimated that the median time to transit the lower Snake River in 1993 was the same or less with dams than it would be without dams, suggesting that adult passage timing through the FCRPS dams and reservoirs is relatively unaffected by the FCRPS. This is due to the faster transit times through project reservoirs than would occur in a naturally flowing river.

5.2.2.3.3 Adult Survival Methods. NOAA Fisheries relied on recent adult fish radio tracking studies to estimate adult passage loss through the FCRPS dams and reservoirs in the reference operation. NOAA Fisheries considers the unaccounted-for adult loss estimate calculated from these studies to be more representative of the mortality rate associated with passage through the FCRPS projects than an adult loss estimate based on a comparison of adult counts between dams. Therefore, data from radio-tagging studies, when available during the 1996-98 and 2000-2002 periods, were used to estimate the unaccounted-for adult loss rate and, as a corollary, the minimum survival rates of listed adults passing through the hydrosystem under the reference operation.

These estimates are considered minimums, because some radio-tagged adults that were considered mortalities due to dam passage in the analysis may have survived or suffered non-dam caused fates. Minimum survival rates were derived by dividing the number of radio-tagged adults detected at an upstream dam by the number of adults tagged minus the number of fish accounted for in the study. Where multi-year study data are available for a particular species, the multiple year results were averaged. See Appendix D, Attachment 4 for a more detailed description of methods used to estimate FCRPS effects on adult passage.

5.2.2.3.4 Adult Survival Estimates. Adult salmon and steelhead must pass up to eight mainstem dams and reservoirs to reach their natal spawning streams and river reaches. Each FCRPS project within currently occupied habitats imposes stresses on migrating adults. Those project-induced effects most likely to adversely affect adult survival are: delay and delay-induced predation, water quality changes (e.g., total dissolved gas concentrations and water temperatures), and fallback and volitional downstream passage (e.g., kelts).

To pass each dam, adult fish must successfully locate and ascend the project fish ladder(s). The ability to successfully pass each dam has been found to be affected by project configuration and various operating characteristics, principally attraction flow rates, project spill patterns, and powerhouse discharge patterns. However, Bjornn *et al.* (2000) estimated that the median time to transit the lower Snake River in 1993 was the same or less with dams than it would be without

dams, suggesting that adult passage timing is relatively unaffected by the FCRPS. This is due to the faster transit times through project reservoirs than would occur in a naturally flowing river.

Available data suggest that projects with well designed and carefully operated fishways result in very low mortality rates for migrating adults. High per-project and system survivals indicate adult salmonid biological requirements are generally being met during passage through the FCRPS under current conditions. However, as suggested by some who commented on the September 2004 draft of this Opinion, additional evaluation is needed to determine spawning success after passage through the FCRPS. It is expected that biological requirements for adult salmon and steelhead migrating through the FCRPS are met under the reference operation. NOAA Fisheries does not expect a substantial difference in adult salmon and steelhead survival rates between the reference operation and the proposed hydro operation.

Adult survival rate estimates for the reference operation are presented in Table 5.2. Some adult mortality is associated with the existence of dams and reservoirs in the FCRPS, even when operated according to the reference operation. It is difficult to interpret the significance of this mortality without also knowing something about the mortality that would likely occur if the dams and reservoirs were not in place. To inform this issue, NOAA Fisheries evaluated the rate of mortality that might occur if the reservoirs and dams were not present. The methods are described in Annex 1 of Appendix A of the 2000 FCRPS Biological Opinion. Two different estimation methods were applied for SR spring/summer chinook, and the results were very close to the estimate of current adult survival through the FCRPS. A qualitative evaluation, including consideration of similar migration rates in impounded and unimpounded reaches, indicated that current SR spring/summer chinook adult survival rates through the FCRPS are very similar to unimpounded survival rates. This qualitative appraisal was also applied to other ESUs, and the same conclusion was reached. The adult survival rates in Table 5.2 are generally higher than the adult survival rates in the 2000 FCRPS Biological Opinion, indicating that it is still reasonable to conclude that adult survival through the FCRPS is similar to survival under unimpounded conditions in the Snake and Columbia rivers.

5.2.3 Indirect Effects of Hydrosystem Mortality on Nutrients in Tributaries

Mortality in the hydrosystem, including the reference operation, reduces the transport of marine-derived nutrients (MDN) to freshwater spawning and rearing areas. Gresh *et al.* (2000) estimated that only 6% to 7% of the marine-derived nitrogen and phosphorus that was delivered to the rivers of the Pacific Northwest 140 years ago is currently returning to those streams. He attributed the loss to habitat changes due to beaver trapping, logging, irrigation, grazing, pollution, dams, urban and industrial development, and commercial and sport fishing. Marine-derived nutrients have been shown to support the growth of coastal populations of coho salmon, which feed on salmon eggs and spawned-out carcasses. Bilby *et al.* (2001) observed an increase in the amount of marine-derived nitrogen in the muscle of coho parr with increasing abundance of carcass tissue up to about 0.01 kg/m^2 and 0.15 kg/m^2-wet weight. Salmon carcasses also appear to promote the growth of riparian forests, the source of large woody debris. Helfield and Naiman (2004) hypothesized that there were several pathways for the transfer of MDN from streams to riparian vegetation, including the transfer of dissolved nutrients from decomposing carcasses into shallow subsurface flow paths and the dissemination in feces, urine, and partially-

eaten carcasses by bears and other salmon eating fauna. In studies with juvenile coho salmon, Quinn and Peterson (1996) correlated increased body size with higher rates of overwinter survival, although this study was not designed to determine whether the effect was related carcass density. Bilby *et al.* (2002) found a positive linear relationship between the biomass of juvenile anadromous salmonids and the abundance of carcass material at sites in the Salmon and John Day rivers, suggesting that spawning salmon may be influencing aquatic productivity and the availability of food for rearing fishes, but mechanisms were not postulated. In summary, there is an increasing body of work suggesting that the biomass of carcasses affects the productivity of salmonid rearing habitat, but functional and quantitative relationships are poorly understood and difficult to generalize from the specific conditions studied.

Table 5.2. Estimated minimum adult survival and unaccounted loss from 1996 through 1998 and 2000 through 2002 through the FCRPS (Bonneville Dam tailrace to Lower Granite or McNary dams). Source: Appendix D, Attachment 4, Table 1.

ESU	Mean Unaccounted Loss	Minimum Mean Survival	Number of Dams Passed	Per Project Survival
Chinook Salmon				
SR spring/summer chinook	0.154 (.064 - .250)	0.846 (.750 - .936)	8	0.979
SR fall chinook	0.153 (.077 - .200)	0.847 ((.800 – 9.23)	8	0.980
UCR spring chinook	0.080 (.065 - .089)	0.920 (.911 - .935)	4	0.979
LCR spring chinook	0.035 (none)	0.965 (none)	1	0.965
LCR fall chinook	0.020 (none)	0.980 (none)	1	0.980
Steelhead				
SR steelhead	0.168 (.101 - .250)	0.833 (.750 - .899)	8	0.977
UCR steelhead	0.059 (.039 - .078)	0.941 (.922 - .961)	4	0.985
MCR steelhead	0.067 (none)	0.933 (none)	3	0.977
LCR steelhead	0.026 (none)	0.974 (none)	1	0.974
LCR coho	0.020 (none)	0.980 (none)	1	0.980
SR sockeye salmon	0.169 (none)	0.831 (none)	8	0.977

5.3 NON-HYDRO ELEMENTS OF THE BASELINE

5.3.1 Predation

Salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation may also contribute to significant natural mortality, although the levels of predation are largely unknown. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebound of seal and sea lion populations, following their protection under the Marine Mammal Protection Act of 1972, has resulted in substantial mortality for salmonids. In recent years, for example, sea lions have learned to target UWR spring chinook salmon in the fish ladder at Willamette Falls.

Dams and reservoirs are generally believed to have increased the incidence of predation over historical levels (Poe *et al.* 1994). Impoundments in the Columbia River basin increase the availability of microhabitats in the range preferred by northern pikeminnow and other predators (Faler *et al*. 1988; Beamesderfer 1992; Mesa and Olson 1993; Poe *et al.* 1994). They also can increase local water temperatures, which increases digestion and consumption rates by northern pikeminnow (Falter 1969; Steigenberger and Larkin 1974; Beyer *et al.* 1988; Vigg and Burley 1991; Vigg *et al.* 1991); decrease turbidity, which may increase capture efficiency of predators (Gray and Rondorf 1986); favor introduced competitors, which could cause some predators to shift to a diet composed largely of juvenile salmonids (Poe *et al.* 1994); and increase stress and subclinical disease of juvenile salmonids, which could increase susceptibility to predation (Rieman *et al.* 1991; Gadomski *et al.* 1994; Mesa 1994). In addition, dam-related passage problems and reduced river discharge can affect the availability, distribution, timing, and aggregation of migrating salmonids, thereby increasing exposure time to predation (Raymond 1968, 1969, 1979, 1988; Park 1969; Van Hyning 1973; Bentley and Raymond 1976). In particular, they can increase exposure time later in the season, when predator consumption rates are high (Beamesderfer *et al.* 1990; Rieman *et al.* 1991). There is also information to suggest that growth of smallmouth bass due to the availability of American shad prey in the late summer and fall could potentially result in a large increase in the number of juvenile salmonids consumed by this predator (Sauter *et al*. 2004).

5.3.1.1 Piscivorous Predation

The Columbia River basin has a diverse assemblage of native and introduced fish species, some of which prey on salmon and steelhead. The primary resident fish predators of salmonids in the reaches of the Columbia and Snake rivers inhabited by anadromous salmon are northern pikeminnow, smallmouth bass, and walleye (NMFS 2000b). Other predatory resident fish include channel catfish, Pacific lamprey, yellow perch, largemouth bass, and bull trout.

Although northern pikeminnow (*Ptychocheilus oregonensis)* are a native species that has always preyed upon juvenile salmonids, development of the Columbia River hydropower system has likely increased the level of predation, as noted above. Northern pikeminnow predation throughout the Columbia and Snake rivers was indexed in 1990-1993 based on electrofishing catch rates of predators and the occurrence of salmonids in predator stomachs relative to

estimates in John Day Reservoir (Ward *et al.* 1995). Northern pikeminnow abundance was estimated to total 1.8 million, and daily consumption rates averaged 0.06 salmonids per predator (Beamesderfer *et al.* 1996).

Beamesderfer *et al.* (1996) estimated that over 16 million total salmonids were consumed annually in the mainstem Columbia and Snake rivers prior to initiation of the Northern Pikeminnow Management Program (NPMP). However, total system-wide impacts are not evenly distributed throughout the Columbia and Snake rivers but are concentrated in the lower Columbia River from The Dalles Reservoir downstream, where approximately 13 million of the 16.4 million total salmonids are estimated to have been consumed by northern pikeminnow. This estimated predation loss is 8% of the approximately 200 million hatchery and wild juvenile salmonid migrants in the system.

Introduced smallmouth bass and walleye are also significant predators of juvenile salmonids. Found in lakes, rivers, and streams, smallmouth bass (*Micropterus dolomieu*) have relatively large mouths that enable them to consume juvenile fish, including salmonids. According to Bennett and Naughton (1999), smallmouth bass and salmonids utilize many of the same habitat types. Smallmouth bass are the dominant predators in reservoirs of the lower Snake River and are co-dominant with northern pikeminnow and percids in certain reaches of the Snake River (NMFS 2000b). The highest densities of smallmouth bass in the Columbia and Snake rivers occur in the Lower Granite forebay, tailrace, and reservoir, followed by the John Day Reservoir (NMFS 2000b). Throughout the John Day Reservoir study area, smallmouth bass consumed far fewer juvenile salmonids than did northern pikeminnow (Zimmerman 1999).

Zimmerman (1999) also found that smallmouth bass consumed smaller chinook salmon in the spring than did northern pikeminnow, and they consumed far more subyearling chinook salmon in the summer than yearling chinook in the spring. Predator-prey size relationships may reflect the degree and timing of habitat overlap, as suggested by Tabor *et al.* (1993), who attributed high levels of smallmouth bass predation on subyearling chinook salmon to overlap of rearing habitat for subyearling chinook with the preferred habitats of smallmouth bass in summer.

As the largest member of the perch family, walleye (*Sander vitreus*) can grow up to 20 pounds, are extremely piscivorous, and are most abundant in dam tailraces, where the potential for impacts on juvenile salmonids is high (NMFS 2000b). One comment on the September 2004 draft of this Opinion questioned why, since the Opinion reported walleye account for one-third of predation on downstream migrants, the Opinion did not focus more on walleye control. In response, NOAA Fisheries conducted a more thorough review of the available literature and found that the general use of the one-third value is likely incorrect and at odds with much of the published literature on predation by fishes in the Columbia River. In the classic 1983-1986 John Day Reservoir study that formed the basis for the current predator management program, Rieman *et al.* (1991) found that walleye consumed 13% of the estimated annual 2.7 million juvenile salmonids consumed by predatory fish. Northern pikeminnow accounted for 78% and smallmouth bass took 9%. Poe *et al.* (1991) stated that walleye are much less important predators than other fish species, and their salmon consumption appeared to consist mostly of subyearling chinook during late summer in the John Day Reservoir. While the John Day Reservoir study found that smallmouth bass were the third most important predator of salmonids, more recent

studies have indicated that there are smallmouth bass hotspots (e.g., The Dalles Dam tailrace) that may be worth further investigation for predator management options.

5.3.1.2 Northern Pikeminnow Management Program (NPMP)

Predator control fisheries have been implemented in the Columbia basin since 1990 to harvest northern pikeminnow with an exploitation rate goal of between 10 and 20% annually. This goal is important, because a 10 to 20% exploitation rate is necessary to obtain up to a 50% reduction in smolts consumed by pikeminnow (Rieman and Beamesderfer 1990). The NPMP is a multi-year, ongoing effort funded by BPA to reduce piscivorous predation on juvenile salmon, primarily through public, angler-driven, system-wide removals of predator-sized northern pikeminnow. From 1991 to 1996, three fisheries (sport-reward, dam angling, and gill net) harvested approximately 1.1 million northern pikeminnow greater than or equal to 250 mm fork length. Total exploitation averaged 12.0% (range, 8.1 to 15.5%) for 1991 to 1996 (Section 6.2.7.1 of 2000 Biological Opinion).

Since program inception in 1990, the NPMP monetary incentive to harvest northern pikeminnow has motivated sports fishermen to remove over two million northern pikeminnow throughout the system. This has reduced predation mortality by an estimated 25% since fishery implementation (Friesen and Ward 1999), which is estimated to equate to approximately 4 million fewer juvenile salmonids consumed by pikeminnow each year. Currently, the annual harvest rate ranges between approximately 8 and 16% of the northern pikeminnow qualifying in size but has averaged approximately 12% in the last number of years. In 2001 and again in 2004, BPA increased the reward, which led to significant increases in both catch and exploitation. Preliminary estimates indicate a 2004 exploitation rate of 16.1% with 95% confidence intervals of 11.8% to 22.5% (Oregon comments on the September 2004 draft of this Opinion). While this rate is higher than previous rates, Oregon also pointed out that relatively wide confidence intervals around recent point exploitation rate estimates overlap and therefore preclude statistical significance. Historically, the NPMP has been evaluated in conjunction with proposed FCRPS operations. As such, the past and present beneficial effects of the NPMP are included in the baseline. However, continuation of the NPMP is part of the UPA and therefore future beneficial effects of the NPMP are not included as part of the baseline.

5.3.1.3 Avian Predation

Avian predation is one of the factors currently limiting salmonid recovery in the Columbia River basin. In the Columbia River Basin, piscivorous birds congregate near hydroelectric dams and in the estuary near man-made islands and structures and eat large numbers of migrating juvenile salmonids (Ruggerone 1986; Roby *et al.* 2003, Collis *et al.* 2002). Diet analyses indicate that juvenile salmonids are a major food source for avian predators in the Columbia River and its estuary and that basin-wide losses to avian predators are high enough that they constitute a substantial portion of each run of salmon (Roby *et al.* 2003).

Caspian terns, double-crested cormorants, glaucous-winged/western gull hybrids, California gulls, and ring-billed gulls are the principal avian predators in the basin (NMFS 2000b). Populations of these birds have increased throughout the basin as a result of nesting and feeding

habitats created by human activities, such as dredge spoil deposition in or near the estuary (which has led to nesting islands) and reservoir impoundments and tailrace bypass outfalls associated with hydro projects (Roby *et al.* 2003). The breeding season for these birds coincides with the juvenile salmon outmigration, which provides a ready prey source in the vicinity of large avian nesting colonies (Roby *et al.* 2003).

For many of the listed salmon species migrating through the Columbia River estuary, avian predation is considered one of the primary limiting factors affecting juvenile survival (Fresh *et al.* 2004). Since 1997, researchers have been studying the effect of piscivorous waterbirds on juvenile salmonid survival in the Lower Columbia River. In 1998, Collis *et al.* (2003) estimated that Caspian terns nesting on Rice Island consumed about 12.4 million juvenile salmonids, or approximately 13% of the estimated 97 million out-migrating smolts that reached the estuary during the 1998 migration year. This research prompted managers to relocate the tern colony to East Sand Island, located approximately 15 miles downstream and near the ocean, which resulted in a successful reduction in predation of juvenile salmonids by approximately five to six million fish annually. However, annual predation rates of terns nesting on East Sand Island are still substantial; on average, terns consumed 5.9 million smolts annually from 2000 to 2003 (Collis *et al*. 2003).

The double-crested cormorant colony on East Sand Island in the Columbia River estuary is the largest along the Pacific coast (Collis *et al.* 2002). In 2003, approximately 10,646 breeding pairs were nesting on East Sand Island. Given the birds' feeding habits, it is difficult to determine the number of juvenile salmonids they consume. However, based on preliminary bioenergetics modeling, it appears that cormorants nesting on East Sand Island consumed about the same numbers of juvenile salmonids as Caspian terns in 2003.

5.3.1.4 Pinniped Predation

Marine mammal predation has increased in recent years in the tailrace below Bonneville Dam, probably in response to increased populations of returning adult spring chinook. Aggregations of over 100 individual pinnipeds, primarily California sea lions with a few Stellar sea lions and Pacific harbor seals, have been observed feeding immediately below the dam, often near the powerhouse fishway entrances. Visual observations have indicated that these pinnipeds consumed 0.3, 1.1, and 2% of the spring chinook salmon run in 2002, 2003, and 2004, respectively (Stansell 2004).

5.3.2 Environmental Condition of the Lower Columbia River and Estuary

As indicated in Chapter 1.0, when it is not possible to evaluate specific reach survivals, NOAA Fisheries will analyze the biological requirements within the action area by assessing the conditions described in the scientific literature as fully functioning and sufficient to support salmonid survival and recovery. For the estuary and Columbia River plume, these conditions vary depending on the species and are discussed in more detail below.

The Columbia River is naturally a dynamic system. It has been affected and shaped over eons by a variety of natural forces, including volcanic activity, storms, floods, natural events, and climate

changes. These forces had and continue to have a significant influence on biological factors, habitat, inhabitants, and the whole riverine and estuarine environment of the Columbia River.

Over the past century, human activities have altered the range of physical forces affecting conditions in the action area, which has resulted in extensive changes to fish habitat in the lower Columbia River and estuary. To some degree, the risk of extinction for salmon stocks in the Columbia River basin has increased, because complex freshwater and estuarine habitats needed to maintain diverse wild populations and life histories have been lost and fragmented. Estuarine habitat has been lost or altered directly through diking, filling, and dredging. Estuarine habitat has also been removed indirectly through changes to flow regulation that affect sediment transport and salinity within specific habitats in the estuary. Not only have rearing habitats been removed, but the habitats needed to support tidal and seasonal movements of juvenile salmon are no longer connected.

Major changes in the estuary resulting from anthropogenic alterations include a loss of vegetated, shallow-water habitat and changes in the size, seasonality, and behavior of the plume. These changes have significant consequences for salmonid diversity and population productivity. In particular, because the changes in habitat are most pronounced in shallow water, effects on the ESUs and fry and fingerling life-history strategies that use and depend upon these shallow-water areas are most significant (Fresh *et al.* 2004).

The lower Columbia River estuary lost approximately 43% of its historical tidal marsh (from 16,180 to 9,200 acres) and 77% of historical tidal swamp habitats (from 32,020 to 6,950 acres) between 1870 and 1970 (Thomas 1983). One example is the diking and filling of floodplains formerly connected to the tidal river that have resulted in the loss of large expanses of low-energy, off-channel habitat for salmon rearing and migrating during high flows. Similarly, diking of estuarine marshes and forested wetlands within the estuary have removed most of these important off-channel habitats. Sherwood *et al.* (1990) estimated that the Columbia River estuary lost 20,000 acres of tidal swamps, 10,000 acres of tidal marshes, and 3,000 acres of tidal flats between 1870 and 1970.

The total volume of the estuary inside the entrance has declined by about 12% since 1868. This study further estimated an 80% reduction in emergent vegetation production and a 15% decline in benthic algal production. Sherwood *et al.* (1990) also analyzed early navigational charts and noted profound changes in the river entrance from year to year. The pre-development river mouth was characterized by shifting shoals, sandbars, and channels forming ebb and flood tide deltas. Prior to jetty construction, the navigable channel over the tidal delta varied from a single, relatively deep channel in some years to two or more shallow channels in other years.

Within the lower Columbia River, diking, river training devices (pile dikes and riprap), railroads, and highways have narrowed and confined the river to its present location. Between the Willamette River and the mouth of the Columbia River, diking, flow regulation, and other human activities have resulted in a confinement of 84,000 acres of floodplain that likely contained large amounts of tidal marsh and swamp. The lower Columbia River's remaining tidal marsh and swamp habitats are located in a narrow band along the Columbia River and tributaries' banks and around undeveloped islands.

Since the late 1800s, the Corps has been responsible for maintaining navigation safety on the Columbia River. During that time, the Corps has taken many actions to improve and maintain the navigation channel. The channel has been dredged periodically to make it deeper and wider and annually for maintenance. To improve navigation and reduce maintenance dredging, the navigation channel has also been realigned and hydraulic control structures, such as in-water fills, channel constrictions, and pile dikes, which act as break-waters, have been built. Most of the present-day pile dike system was built in the periods 1917-23 and 1933-39, with an additional 35 pile dikes constructed between 1957 and 1967.

The existing navigation channel pile dike system consists of 256 pile dikes, totaling 240,000 linear feet. Ogden Beeman and Associates (1997) noted that navigation channel maintenance activities from 1885 to 1985 required closing of river side channels, realigning river banks, removing rock sills, stabilizing river banks, and placement of river "training" features. Most of these habitat alterations were constructed or occurred before any of the current ESA-listed salmonids were placed on the list of endangered and threatened species.

Flow regulation, water withdrawal, and climate change have reduced the Columbia River's average flow and altered its seasonality, sediment discharge and turbidity, changing the estuarine ecosystem (National Research Council 1996; Sherwood *et al.* 1990; Simenstad *et al*. 1982, 1990; Weitkamp 1994). Annual spring freshet flows through the Columbia River estuary are approximately one-half of the traditional levels that flushed the estuary and carried smolts to sea, and total sediment discharge is approximately one-third of 19th-century levels. For instance, flow regulation that began in the 1970s has reduced the 2-year flood peak discharge, as measured at The Dalles, Oregon, from 580,000 cfs to 360,000 cfs (Corps 1999).

Decreased spring flows and sediment discharges have also reduced the extent, speed of movement, thickness, and turbidity of the plume that extended far out and south into the Pacific Ocean during the spring and summer (Cudaback and Jay 1996; Hickey *et al*. 1997). Changes in estuarine bathymetry and flow have altered the extent and pattern of salinity intrusion into the river and have increased stratification and reduced mixing (Sherwood *et al.* 1990).

These aforementioned physical changes also affect other factors in the riverine and estuarine environment. Tides raise and lower river levels at least 4 feet and up to 12 feet twice every day. The historical range for tides was probably similar, but seasonal ranges and extremes in water surface elevations have certainly changed because of river flow regulation. The salinity level in areas of the estuary can vary from zero to 34 parts per thousand (ppt), depending on tidal intrusion, river flows, and storms. The salinity wedge is believed to have ranged from the river mouth to as far upstream as RM 37.5 in the past. It is now generally believed that the upper edge of the wedge ranges between the mouth and RM 30. The river bed within the navigation channel is composed of a continuously moving series of sand waves that can migrate up to 20 feet per day at flows of 400,000 cfs or greater and at lesser rates at lower flows. This rate of discharge is not experienced as often as it was prior to flow regulation in the Columbia River.

As development has changed the circulation pattern in the estuary, it has increased shoaling rates. Sediment input to the estuary has declined due to the altered riverine hydrograph, and the

estuary is now a more effective sediment trap (Independent Science Group 1996). Although the Columbia River is characterized as a highly energetic system, it has been changing as a result of development and is now similar to more developed and less energetic estuaries throughout the world (Sherwood *et al.* 1990).

Water and sediment quality is another important aspect of the environmental condition of the Lower Columbia River and ecosystem with the potential to affect salmonids' growth and survival. The uptake of toxicants during juvenile salmonid residence in the Lower Columbia River and estuary (NWFSC Environmental Conservation Division 2001) can affect growth and survival. In field studies, juvenile salmon from sites in the Pacific Northwest have demonstrated immunosuppression, reduced disease resistance, and reduced growth rates due to contaminant exposure during their period of estuarine residence (Arkoosh *et al.* 1991, 1994, 1998; Varanasi *et al.* 1993; Casillas et al. 1995a, 1995b, 1998a).

Current environmental conditions in the Columbia River estuary indicate the presence of contaminants in the food chain of juvenile salmonids. In fish from a site near Sand Island at the mouth of the Columbia River, whole body concentrations of dichlorodiphenyl trichloroethane (DDT) and polychlorinated biphenyls (PCBs) were 44 ng/g wet wt (~ 220 ng/g dry wt) and 53 ng/g wet wt (~ 265 ng/g dry wt), respectively (NWFSC Environmental Conservation Division 2001). The findings of elevated levels of DDT and PCBs in stomach contents of fish from Sand Island is clear evidence that fish are being exposed to these contaminants while they are in the estuary. Levels of DDT in stomach contents were 52 ng/g wet weight, and levels of PCBs were 33 ng/g wet weight. Although the Sand Island samples were collected from a mixed population of hatchery and wild fish., and it is likely that DDT and PCBs in hatchery food make some contribution to contaminant body burdens, the values seen were among the highest levels measured at estuarine sites in Washington and Oregon. By comparison, in the Duwamish estuary, a heavily contaminated industrial estuary near Seattle, mean whole body DDT levels in juvenile chinook salmon were 25 ng/g wet wt (~125 ng/g dry wt), and whole body PCB levels were 68 ng/g wet wt (~340 ng/g dry wt)(NWFSC Environmental Conservation Division 2001).

More recently, additional samples were analyzed from salmon collected in 1999 and 2000 (NWFSC Environmental Conservation Division 2001). These analyses showed that concentrations of PCBs and DDT are consistently elevated in chinook salmon collected from Sand Island in the mouth of the Columbia River. Measured concentrations of DDT in salmon bodies ranged from 32 to 56 ng/g dry wt, and concentrations of PCBs ranged from 23 to 160 ng/g dry wt (NWFSC Environmental Conservation Division 2001). No significant differences in mean concentrations of either of these contaminants were found over the three years during which fish were sampled. Elevated levels of PCBs and DDT were also consistently found in stomach contents of sampled fish, indicating that juvenile salmon caught near Sand Island are taking these contaminants up in their diet.

The concentrations of PCBs present in Sand Island fish are a cause for concern, because they are approaching or even exceeding estimated threshold tissue concentrations for adverse effects in salmonids (Meador 2000). These values range from 120-360 ng/g dry wt for fish with total body lipid concentrations of 1-3%, which are typical of juvenile salmon collected within Pacific

Northwest estuaries. At an average of 265 ng/g dry wt, PCB concentrations in Sand Island fish are well within the range of the effects threshold.

Available data suggest that exposure to polyaromatic hydrocarbons (PAH) may be quite variable in juvenile salmon from the lower Columbia River. In stomach contents of juvenile chinook salmon collected near Sand Island in 1998, PAH concentrations were barely detectable, below levels seen in salmon from moderately developed estuaries such as Yaquina Bay and Grays Harbor, and well below levels found in stomach contents of salmon from industrialized waterways of Puget Sound (e.g., Hylebos Waterway) (NWFSC Environmental Conservation Division 2001). Similarly, concentrations of PAH metabolites in bile were relatively low in juvenile salmon from Sand Island in comparison to fish from urban Puget Sound sites (e.g., the Duwamish and Hylebos Waterways) (NWFSC Environmental Conservation Division 2001). Juvenile salmon sampled near Sand Island in 2000, however, showed somewhat greater exposure to PAHs than salmon sampled in 1998. Concentrations of PAHs and their metabolites in both stomach contents and fish bile were considerably higher in 2000 than in 1998 (NWFSC Environmental Conservation Division 2001). Concentrations were still lower than those observed in fish from urban estuaries in Puget Sound but were comparable to those observed in fish from estuaries with moderate development along the Washington and Oregon coast, such as Yaquina Bay or Coos Bay. These data indicate that juvenile salmonids within the Columbia River estuary have contaminant body burdens that may already be within the range where sublethal effects may occur, although the sources of exposure could be widespread and are not clear.

The next step is to analyze the effect of the environmental baseline on the biological requirements within the action area. For all ESUs, an addition to the environmental baseline is the Columbia River Channel Improvements Project (Biological Opinion, Columbia River Federal Navigation Channel Improvements Project, May 20, 2002). This project included improvements to the main Columbia River navigation channel, ecological restoration activities in the Lower Columbia River, and other associated activities. The channel improvements included the deepening of the main navigation channel in the Lower Columbia River and improvements to ship turning basins. Construction and maintenance of seven ship berths in the Lower Columbia River were considered interrelated and/or interdependent actions.

5.3.3 Mainstem Environmental Baseline

As indicated in Chapter 1.0, when it is not possible to evaluate specific reach survivals, NOAA Fisheries will analyze the biological requirements within the action area by assessing the conditions described in the scientific literature as fully functioning and sufficient to support salmonid survival and recovery. For the Columbia River mainstem, these conditions vary depending on the species and are discussed in more detail below.

In general, the mainstem and tributary environment for listed species in the Columbia River Basin (CRB) has been dramatically affected by the development and operation of the FCRPS. Storage dams have eliminated mainstem spawning and rearing habitat and have altered the natural flow regime of the Snake and Columbia rivers, decreasing spring and summer flows, increasing fall and winter flows, and altering natural thermal patterns. Power operations have

caused fluctuating flow levels and river elevations, affecting fish movement through reservoirs, disturbing riparian areas and possibly stranding fish in shallow areas as flows recede. The eight dams in the migration corridor of the Snake and Columbia rivers kill or injure a portion of the smolts passing through the area. The low velocity at which water travels through the reservoirs behind the dams slows the smolts' journey to the ocean and enhances the survival of predatory fish (Independent Scientific Group 1996; National Research Council 1996). Formerly complex mainstem habitats in the Snake River have been reduced, for the most part, to single channels, with floodplains reduced in size and off-channel habitats eliminated or disconnected from the main channel (Sedell and Froggatt 1984; Independent Scientific Group 1996; Coutant 1999). The amount of large woody debris in the river has declined, reducing habitat complexity and altering the river's food webs (Maser and Sedell 1994).

Of particular significance, the Columbia River dams have substantially disrupted sediment transport within the river channel. For example, as the Snake and Clearwater rivers meet the slack water of Lower Granite Reservoir, bed load and suspended particles soon settle to the river bottom, resulting in a substantial accumulation of sediment near the head of the reservoir. The Corps estimates that 2.6 million cubic yards of sediment enter Lower Granite Reservoir annually. Under the conditions of the environmental baseline, the existence and operation of the lower Snake River dams and reservoirs prevent the normative transport and deposition of this sediment. Without the dams, finer grained materials would tend to be deposited on the river floodplain or high along the channel margins, and the riverbed would present a complex mosaic of substrate conditions along the length of the lower Snake River. Presently, there are few shallow-water sandy shoals below the confluence area. Consequently, smolts, which feed during the seaward migrations through the Columbia River, must travel substantial distances between foraging areas. There are also few accumulations of suitable spawning gravels for fall chinook, except in the tailraces of the dams.

There have been numerous changes in the operation and configuration of the FCRPS as a result of ESA consultations among the Action Agencies, NOAA Fisheries, and USFWS. The changes have improved survival for the listed fish migrating through the Snake and Columbia rivers. As described in Section 5.2.2.1, at the time of listing of the Snake River sockeye and spring/summer and fall chinook ESUs, safe passage for juvenile fish was substantially lower than it is under the current environmental baseline in 2004. In 1991, for example, NOAA Fisheries estimated cumulative passage mortality for Snake River Spring/summer Chinook juveniles to be approximately 91% (9% survival) through eight dams and reservoirs (NMFS 1991a). The survival estimate cited in 1991 included conditions in the 1970s and 1980s that had improved by the time of listing. Retrospective in-river survival estimates in Appendix D for 1994 and 1995, which include conditions that had improved somewhat from the time of listing, range from 23-37% for SR spring/summer chinook and 14% for SR fall chinook (1995 only). The SR sockeye estimates would be somewhat less than the 23-37% SR spring/summer chinook estimate. The habitat conditions existing at the time of listing for these stocks are documented in the Factors for Decline analyses prepared for each of these Snake River ESUs (NMFS 1991a, 1991b).

Although remedial passage improvements may have accrued due to changes in FCRPS operations and configuration, including juvenile transportation around portions of the

hydrosystem, periods of warm weather and low runoff continue to cause high rates of mortality among out-migrants in Lower Granite Reservoir. Lower Granite is the uppermost reservoir in the FCRPS and fish must negotiate this reach without the aid of transportation (i.e., the juvenile collection facilities are further downstream at Lower Granite Dam).

Water quality in streams throughout the Columbia River basin has been degraded by human activities such as dams and diversion structures, water withdrawals, farming and grazing, road construction, timber harvest activities, mining activities, and urbanization. Over 2,500 streams and river segments and lakes do not meet Federally approved, state and Tribal water quality standards and are now listed as water-quality-limited under Section 303(d) of the Clean Water Act (CWA). Tributary water quality problems contribute to poor water quality where sediment and contaminants from the tributaries settle in mainstem reaches and the estuary.

The Snake River from its confluence with the Salmon River at RM 188 to its confluence with the Columbia River has been included on the 303(d) list (a list of impaired waters compiled under Section 303(d) of the CWA) for temperature by Idaho, Oregon, and Washington. Additionally, Oregon and Washington have most of the Columbia River on their lists for temperature. Most of the water bodies in Oregon, Washington, and Idaho that are on the 303(d) list do not meet water quality standards for temperature or flow alteration. Temperature alterations affect salmonid metabolism, growth rate, and disease resistance, as well as the timing of adult migrations, fry emergence, and smoltification. Many factors can cause high stream temperatures, but they are primarily related to land- and water-use practices rather than point-source discharges.

Some common actions that have resulted in high stream temperatures are the removal of trees or shrubs that directly shade streams, excessive water withdrawals for irrigation or other purposes, and warm irrigation return flows. Loss of wetlands and increases in groundwater withdrawals have contributed to lower base-stream flows, which in turn contribute to temperature increases.

Background or ambient levels of pollutants in inflows carry cumulative loads from upstream areas in variable and generally unknown amounts. Municipal and industrial waste discharges have occurred in the greater Lewiston, Idaho-Clarkston, Washington area and have been received from larger population centers in the upper Snake River basin. Major tributaries and drainages have delivered higher background concentrations of metals, which are generally associated with mining areas that are common in portions of the Clearwater and Salmon rivers and in tributaries throughout the upper Snake River.

Contamination from pesticides is associated with upstream agricultural areas. These contaminants are primarily attached to organic matter that is delivered to depositional areas where sediments accumulate. The Lower Granite Reservoir has also received high loads of inorganic sediments from the Clearwater, Salmon, and Grande Ronde rivers. The Clearwater River confluence with the Snake River is at the upstream entrance to Lower Granite Reservoir. In this reach, inorganic and organic sediment deposition rates have been the highest, because the reservoir slows the velocity of both rivers, thus allowing most particulates to settle out within the upper portions of Lower Granite Reservoir.

The next step is to analyze the effect of the environmental baseline on the biological requirements within the action area. For ESUs using portions of the mainstem, additions to the environmental baseline follow. The Corps constructed riprap levees along the lower Snake and Clearwater rivers and regularly dredges sediment from channels in the upper part of Lower Granite Reservoir in order to maintain flood conveyance and navigation channels to ports in the Lewiston and Clarkston area. These actions were analyzed in NOAA Fisheries' March 15, 2004 biological opinion, "Lower Snake and Clearwater Rivers 2004-2005 Dredging Snake River Fall Chinook, Snake River Spring/Summer Chinook, and Snake River Steelhead" (NOAA Fisheries 2004e), and are part of the environmental baseline for this Opinion. Discharge from Potlatch mill into the surface waters and sediments in the lower Clearwater and Snake Rivers is expected to increase levels of total suspended solids and elevate concentrations of some organic constituents. This action was analyzed in NOAA Fisheries April 2, 2004 biological opinion, "Potlatch Pulp and Paper Mill, Lewiston, Idaho, National Pollution Discharge Elimination System (NPDES) Permit No.: ID-000116-3 for the discharge of effluents into the Snake River, Nez Perce County, Idaho and Asotin County, WA (1 Project)" (NOAA Fisheries 2004f), and is part of the environmental baseline for this Opinion. Levee ponds that collect stormwater runoff from the cities of Lewiston and Clarkston and possibly also seepage from the mill site have been discharged into the lower Clearwater River.

5.3.4 Tributary Baseline

As indicated in Chapter 1.0, when it is not possible to evaluate specific reach survivals, NOAA Fisheries will analyze the biological requirements within the action area by assessing the conditions described in the scientific literature as fully functioning and sufficient to support salmonid survival and recovery. This can often involve analyzing limiting factors, i.e., factors preventing the habitat from achieving a condition that is fully functioning and sufficient to support salmonid survival and recovery. Human activities that have degraded aquatic habitats or affected native fish populations in the Columbia River Basin tributaries include stream channelization, elimination of wetlands, construction of flood control dams and levees, construction of roads (many with impassable culverts), timber harvest, splash dams, mining, water withdrawals, unscreened water diversions, agriculture, livestock grazing, urbanization, outdoor recreation, fire exclusion/suppression, artificial fish propagation, fish harvest, and introduction of non-native species (Henjum *et al.* 1994; Rhodes *et al.* 1994; National Research Council 1996; Spence *et al.* 1996; and Lee *et al.* 1997). In many watersheds, land management and development activities have reduced connectivity (i.e., the flow of energy, organisms, and materials) between streams, riparian areas, floodplains, and uplands; elevated fine sediment yields, degrading spawning and rearing habitat: reduced large woody material that traps sediment, stabilizes streambanks, and helps form pools; reduced vegetative canopy that minimizes solar heating of streams; caused streams to become straighter, wider, and shallower, thereby reducing rearing habitat and increasing water temperature; altered peak flow volume and timing, leading to channel changes and potentially altering fish migration behavior; and altered floodplain function, water tables and base flows (Henjum *et al.* 1994; McIntosh *et al.* 1994; Rhodes *et al.* 1994; Wissmar *et al.* 1994; National Research Council 1996; Spence *et al.* 1996; and Lee *et al.* 1997). Tributary habitat, including factors limiting viability, are described for specific ESUs in Section 5.4.

The next step is to analyze the effect of the environmental baseline on the biological requirements within the action area. For tributary subbasins NOAA Fisheries' process, data sources and characterization of the environmental baseline is laid out in Appendix E. In conjunction with that aspect of the environmental baseline NOAA also considered the effects of additions to the environmental baseline. In its approach to additions to the tributary environmental baseline, NOAA Fisheries considered the beneficial and adverse effects of past and current non-Federal actions and Federal actions that have undergone Section 7 consultation. Both types of information were considered in assessing the type and extent of factors limiting listed salmonids in the action area and in estimating the potential to improve habitat conditions through restoration actions (Appendix E).

In evaluating Federal actions, NOAA Fisheries relied on its consultation records, including the Public Consultation Tracking System (PCTS) database of individual formal and informal Federal consultations. Federal actions authorized and implemented through programmatic consultations, and therefore not subject to individual consultations, do not appear in the PCTS database. These were evaluated through a review of available annual reports submitted by the responsible Federal agencies.

5.3.5 Artificial Propagation Programs

Artificial propagation programs mandated by Congress under the Lower Snake River Compensation Program are included in the environmental baseline for this consultation. The artificial propagation facilities under this program were originally authorized to help mitigate for the construction of the four Federal lower Snake River hydroelectric dams. Other artificial propagation programs in the Snake Basin are not included in the environmental baseline for this consultation as other Federal programs are currently undergoing consultation.

All Federal and non-Federal artificial propagation programs in the Columbia basin above Priest Rapids Dam are included in the environmental baseline for this consultation. The current Section 7 biological opinion for hatchery operations associated with unlisted salmon species (for Federally funded programs) and Permit 1347 (for state-operated programs) both expire October 22, 2013. ESA permits (1396, USFWS and 1412, Confederated Tribes of the Colville Reservation) associated with listed steelhead are in place through October 2, 2008, and permit 1395 (issued to WDFW) are in place through October 2, 2013. ESA permit 1300 issued to the USFWS to propagate listed spring chinook salmon is in place through December 31, 2007, and permit 1196 issued to WDFW expires January 20, 2014.

Artificial propagation programs in the Columbia Basin below the confluence with the Snake River are not included in the environmental baseline for this consultation. New ESA authorization is in process for these programs.

For more than 100 years, hatcheries in the Pacific Northwest have been used primarily to produce fish for harvest and replace natural production lost to dam construction and other development. They have been used only minimally to protect and rebuild naturally produced salmonid populations (e.g., Redfish Lake sockeye). As a result, a large proportion of salmonids returning to the region are first-generation hatchery-origin fish. In 1987, for example, 95% of the

coho salmon, 70% of the spring chinook salmon, 80% of the summer chinook salmon, 50% of the fall chinook salmon, and 70% of the steelhead returning to the Columbia River Basin originated in hatcheries (CBFWA 1990). Because hatcheries have traditionally focused on providing fish for harvest, it is only recently that the substantial adverse effects of hatcheries on natural populations have been demonstrated. For example, hatchery practices, among other factors, have contributed to the 90% reduction in natural coho salmon runs in the lower Columbia River over the past 30 years (Flagg *et al.* 1995).

NOAA Fisheries has identified four primary ways hatcheries harm natural-origin salmon and steelhead: 1) ecological effects, 2) genetic effects, 3) over-harvest effects, and 4) masking effects (Appendix F). Ecologically, hatchery-origin fish can prey on, displace, and compete with natural fish. These effects are most likely to occur when hatchery-reared juveniles are released in poor condition and remain in the streams for extended rearing periods rather than migrating to marine waters. Hatchery-origin fish also may transmit hatchery-borne diseases, and hatcheries themselves may release disease-carrying effluent into streams. Hatchery-origin fish can affect the genetic variability of native fish by interbreeding with them. Outbreeding depression can also result from the introduction of stocks from other areas. Genetic interactions like these can result in fish being less adapted to the local habitats where the original native stock evolved and may therefore be less productive there.

In many areas, hatchery-origin fish provide increased fishing opportunities. However, when natural fish mix with hatchery-origin fish in these areas, naturally produced fish can be over-harvested. Moreover, when migrating adult hatchery and natural fish mix on the spawning grounds, the health of the natural runs and the habitat's ability to support them can be overestimated, because the hatchery fish mask the actual natural run status from surveyors' observations.

The role hatcheries play in the Columbia basin is being redefined by NOAA Fisheries' proposed hatchery listing policy, developing environmental impact statements, and recovery planning efforts. These efforts will focus on maintaining and improving ESU viability. Research designed to clarify interactions between natural and hatchery fish and quantify the effects of artificial propagation on natural fish will play a pivotal role in informing these efforts. The final facet of these initiatives is to use hatcheries to create fishing opportunities that are benign to listed populations (e.g., terminal area fisheries).

5.3.6 Harvest

Treaty Indian fishing rights are included in the environmental baseline for this consultation. The four Columbia River "Stevens" Treaty Tribes (the Nez Perce, Umatilla, and Warm Springs Tribes, and the Yakama Indian Nation) entered into treaties with the United States in 1855. In exchange for the Indians relinquishing their interest in certain lands, the treaties reserved to the Tribes "exclusive" on-reservation rights and the right to take "fish at all usual and accustomed places in common with citizens of the United States" outside the reservations on the Columbia River and major tributaries. Indian treaty rights such as hunting and fishing rights and water rights are reserved rights that generally date from time immemorial. See, Felix S. Cohen, *Handbook of Federal Indian Law*, 441-448 (1982); *United States v. Winans*, 198 U.S. 371, 381

(1905), 25 S.Ct. 662, 49 L.Ed. 1089 ("In other words, the treaty was not a grant of rights to the Indians, but a grant of right from them -- a reservation of those not granted. . . . There was an exclusive right of fishing reserved within certain boundaries. There was a right outside of those boundaries reserved 'in common with the citizens of the territories.'"); *United States v. Adair*, 723 F.2d 1394, 1412-1414 (9th Cir. 1983), *cert. denied sub nom Oregon v. United States*, 467 U.S. 1252 (1984) ("Accordingly, we agree with the district court that within the 1864 Treaty is a recognition of the Tribe's aboriginal water rights and a confirmation to the Tribe of a continued water right to support its hunting and fishing lifestyle on the [former] Klamath Reservation. Such water rights necessarily carry a priority date of time immemorial.").

Treaty Indian fishing rights in the Columbia basin are under the continuing jurisdiction of the U.S. District Court for the District of Oregon in the case of *United States v. Oregon*, No. 68-513 (D. Oregon, continuing jurisdiction case filed in 1968). The parties to *U.S. v. Oregon* are the United States acting through the Department of the Interior (U.S. Fish and Wildlife Service and Bureau of Indian Affairs) and Department of Commerce (NOAA Fisheries), the Warm Springs, Umatilla, Nez Perce, Yakama, and Shoshone-Bannock Tribes, and the states of Oregon, Washington, and Idaho.

In *U.S. v. Oregon*, the court affirmed that the treaties reserved for the Tribes 50% of the harvestable surplus of fish destined to pass through their usual and accustomed fishing areas. In at least a half-dozen published opinions and several unpublished opinions in *U.S. v. Oregon*, as well as dozens of rulings in the parallel case in *U.S. v. Washington* (interpreting the same treaty language for Tribes in the Puget Sound area), the courts have established a large body of case law setting forth the fundamental principles of treaty rights and the permissible limits of conservation regulation of treaty fisheries.

While the general principles for quantifying treaty Indian fishing rights are well established, their application to individual runs during the annual spring and fall fishing seasons is problematical. Annual calculations of allowable harvest rates depend (among other things) on estimated run sizes for the particular year, on the mix of stocks that is present, on application of the ESA to mixed-stock fisheries, on application of the tenets of the "conservation necessity principle" to regulation of treaty Indian fisheries, and on the effect of both the ESA and the conservation necessity principle on treaty and non-treaty allocations. While the precise quantification of treaty Indian fishing rights during a particular fishing season often cannot be established by a rigid formula, the treaty fishing right itself continues to exist and must be accounted for in the environmental baseline.

The quantification of the right in a particular year is subject to negotiations in *U.S. v. Oregon*, in which the parties seek to quantify the Tribal right and associated non-Tribal fishing, subject to ESA-imposed constraints for listed species. A critical harvest management issue under *U.S. v. Oregon* involves what are called "mixed-stock fisheries." Depressed or listed populations are often in the river at the same time as healthy and harvestable stocks of various hatchery and wild components of the runs and are caught incidentally in fisheries that target the healthy stocks. Therefore, harvest must be very carefully managed to provide maximum opportunity to harvest healthy runs while minimizing impact on listed species.

Starting in 1977, Tribal and state fisheries subject to *U.S. v. Oregon* have been regulated pursuant to a series of court orders reflecting court-approved settlement agreements among the parties. The last long-term agreement, known as the Columbia River Fishery Management Plan ("CRFMP"), was adopted and approved by the Court in 1988 and expired in 1999. At the Court's direction and under its supervision, the parties are currently in the process of negotiating a new long-term agreement.

During the past 10 years, harvest has been managed pursuant to the CRFMP and successor agreements that contain restraints on the fisheries necessitated by the ESA listings of some of the ESUs. As a result, NOAA Fisheries has conducted ESA Section 7 consultations and issued no-jeopardy opinions covering these agreements and their impact on ESA-listed species.

As of August 2004, there are two interim Court-approved settlement agreements in place in *U.S. v. Oregon*. One is a Spring Agreement entered into in 2001, which will continue to set harvest rates through spring of 2005; the other is the 2004 Fall Agreement, which will remain in effect through December 2004. Agreed-to and estimated harvest rates for various stocks under the current agreements are set forth in Tables 5.3 and 5.4. For the purpose of projecting the environmental baseline into the future, the tribal treaty right must be included as indicated. In terms of the analysis in the Opinion, it does not matter whether the tribes harvest all of the harvest available to them or, as has been the practice, allocate a portion of that harvest to the states. Accordingly, in order to estimate the extent of this baseline harvest, NOAA Fisheries will presume that treaty and non-treaty harvest rates comparable to the current harvest rates will continue into the future pursuant to Court-approved settlement agreements. In addition, the Colville Confederated Tribal fisheries have been consulted on and remain in effect through October 2012.

Table 5.3. Expected harvest rates for listed salmonids in winter, spring, and summer season fisheries in the mainstem Columbia River and in tributary recreational fisheries under the 2001 - 2005 Spring Agreement in *U.S. v Oregon*. NA - similar estimates not available for other areas. (Table modified from NMFS 2004a)

ESU	Non-Indian Fisheries		Treaty Indian Fisheries
	Mainstem	Tributary[c] Fisheries	Mainstem
Snake River fall chinook	0	0	0
Snake River spring/summer chinook	<0.5-2.0%[a]	NA	5.0-15.0%[a]
Upper Columbia River spring chinook	<0.5-2.0%[a]	NA	5.0-15.0%[a]
Lower Columbia River chinook	2.7%[b]	NA	0
Upper Willamette River chinook	<15%[d]	-[d]	0
Snake River steelhead			
A-run	0.2%	2.5%[e]	2.7%[f]
B-run	0	2.5%[e]	0[f]
Upper Columbia River steelhead			
Naturally-produced	0.6%	NA	3.8%
Hatchery-produced	4.5%	NA	2.7%
Mid-Columbia River steelhead	<2.0%[g]	NA	3.6%
Lower Columbia River steelhead	<2.0%[g]	NA	1.6%
Upper Willamette River steelhead	<2.0%[g]	<1.2%	0
Lower Columbia River coho	0	0	0
Columbia River chum	0	0[h]	0
Snake River sockeye	<1.0%	0	<7.0%

[a] Allowable harvest rate varies depending on run size.
[b] Spring component of the Lower Columbia River ESU only.
[c] Impacts in tributary fisheries will be population specific depending on where the fisheries occur.
[d] Harvest rate limited to 15% or less in all non-Indian mainstem and tributary fisheries.
[e] Maximum harvest rate applied to wild fish passing through terminal fishery areas where hatchery fish are being targeted; hooking mortality of 5% applied to an assumed 50% encounter rate. Harvest rates to stocks not passing through targeted terminal fishing areas will be less.
[f] B-run steelhead of the current return year are primarily caught in fall season fisheries. However, a portion of the summer steelhead run holds over in the Lower Columbia River above Bonneville dam until the following winter and spring; these fish, thought to be mostly A-run, are caught in fisheries in those seasons.
[g] Harvest rate limits for winter-run populations.
[h] Chum may be taken occasionally in tributary fisheries below Bonneville Dam. Retention is prohibited.

Table 5.4. Expected harvest rates for listed salmonids in fall season fisheries in the mainstem Columbia River under the 2004 Fall Agreement in *U.S. v Oregon*. (Table modified from NMFS 2004a)

ESU	Non-Indian Fisheries	Treaty Indian Fisheries
Snake River fall chinook	8.25%	23.04%
Snake River spr/sum chinook	0	0
Upper Columbia River spring chinook	0	0
Lower Columbia River chinook		
Spring component	0%	0%
Tule component	12.4%	0%
Bright component	11.8%	0%
Upper Willamette River chinook	0	0
Snake River steelhead		
A-run	≤2% (1.1%)[a]	3.4%
B-run	≤2% (1.7%)[a]	15% (13.6%)[a]
Upper Columbia River steelhead		
Natural-origin	≤2% (1.1%)[a]	3.4%
Hatchery-origin	10.9%	5.7%
Mid-Columbia River steelhead	≤2% (1.1%)[a]	3.4%
Lower Columbia River steelhead	≤2% (0.3%)[a]	0.1%
Upper Willamette River steelhead	0	0
Lower Columbia River coho	6.4%	0
Columbia River chum	5% (1.6%)[a]	0%
Snake River sockeye	[b]	[b]

[a] Maximum proposed harvest rates with the expected harvest rates associated with the proposed fisheries shown in parenthesis.

[b] 8% cap (combined Tribal and non-Tribal harvest)

5.3.7 Population Response to Environmental Variation

Changes in the abundance of salmonid populations are substantially affected by changes in the freshwater and marine environments. For example, large-scale climatic regimes, such as El Niño, affect changes in ocean productivity. Much of the Pacific Coast was subject to a series of very dry years during the first part of the 1990s and since 2000. In the latter 1990s, severe flooding adversely affected some stocks. For example, the low return of Lewis River bright fall chinook salmon in 1999 is attributed to flood events during 1995 and 1996.

Among the known variations in ocean conditions are the phenomena termed El Niño and the Pacific Decadal Oscillation (PDO).

El Niño is a disruption of the ocean-atmosphere system in the tropical Pacific having important consequences for global weather patterns and near-shore Pacific Ocean productivity. Among these consequences are warmer near-surface ocean water temperatures along the U.S. west coast and generally warmer, drier weather in the Pacific Northwest. This warmer surface layer reduces thermodynamic upwelling off the U.S. coast, reducing nutrient inputs to the euphotic zone, which reduces near-shore ocean productivity. This reduction in productivity has been shown to reduce juvenile salmon growth and survival (Mantua and Francis in press). Warmer surface waters can also change the spatial distribution of marine fishes with potential predator-prey effects on salmon. The warmer, drier weather in the Pacific Northwest often associated with El Niño can also cause or increase the severity of regional droughts. Droughts reduce streamflows through the Columbia and Snake river migratory corridor, increase water temperatures, and reduce the extent of suitable habitat in some drainages. Each of these physical effects has been shown to adversely affect salmon survival. Thus, El Niño events can present a substantial drag on anadromous fish populations.

> The PDO is a long-lived El Niño-like pattern of Pacific climate variability. While the two climate oscillations have similar spatial climate fingerprints, they have very different behavior in time. Fisheries scientist Steven Hare coined the term "Pacific Decadal Oscillation" (PDO) in 1996 while researching connections between Alaska salmon production cycles and Pacific climate. Two main characteristics distinguish the PDO from El Niño. First, 20th century PDO "events" persisted for 20 to 30 years, while typical El Niño events persisted for 6 to 18 months. Second, the climatic fingerprints of the PDO are most visible in the North Pacific/North American sector, while secondary signatures exist in the tropics. The opposite is true for El Niño. Several independent studies find evidence for just two full PDO cycles in the past century. "Cool" PDO regimes prevailed from 1890-1924 and again from 1947-1976, while "warm" PDO regimes dominated from 1925-1946 and from 1977 through (at least) the mid-1990s. Shoshiro Minobe has shown that 20th-century PDO fluctuations were most energetic in two general periodicities, one from 15 to 25 years, and the other from 50 to 70 years. *(*Quoted from:.http://tao.atmos.washington.edu/pdo/)

Major changes in northeast Pacific marine ecosystems have been correlated with phase changes in the PDO. Warm eras have seen enhanced coastal ocean biological productivity in Alaska and inhibited productivity off the west coast of the contiguous United States, while cold PDO eras have seen the opposite north-south pattern of marine ecosystem productivity.

Causes for the PDO are not currently known. Likewise, the potential predictability for this climate oscillation is not known. Some climate simulation models produce PDO-like oscillations, although often for different reasons. The mechanisms giving rise to PDO will determine whether skillful, decades-long PDO climate predictions are possible. For example, if PDO arises from air-sea interactions that require 10-year ocean adjustment times, then aspects of the phenomenon will (in theory) be predictable at lead times of up to 10 years. Even in the absence of a theoretical understanding, PDO climate information improves season-to-season and year-to-year climate forecasts for North America because of its strong tendency for multi-season and multi-year persistence. From a societal impacts perspective, recognition of PDO is important, because it

shows that "normal" climate conditions can vary over time periods comparable to the length of a human's lifetime.

Recent evidence suggests that marine survival of salmonids fluctuates in response to the PDO's 20- to 30-year cycles of climatic conditions and ocean productivity (Cramer *et al.* 1999). Ocean conditions that affect the productivity of Northwest salmonid populations appear to have been in a low phase of the cycle for some time and to have been an important contributor to the decline of many stocks. The survival and recovery of these species will depend on their ability to persist through periods of low natural survival.

A key factor substantially affecting many West Coast stocks has been the general pattern of a 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood. The pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is presumed that survival is driven largely by events occurring between ocean entry and recruitment to a subadult life stage. One indicator of early ocean survival can be computed as a ratio of coded-wire-tag (CWT) recoveries of subadults relative to the number of CWTs released from that brood year. Time series of survival rate information for UWR spring chinook, Lewis River fall chinook, and Skagit fall chinook salmon show highly variable or declining trends in early ocean survival, with very low survival rates in recent years (NMFS 1999b).

5.4 FACTORS AFFECTING THE SPECIES' ENVIRONMENT IN THE ACTION AREA

5.4.1 Snake River Spring/Summer Chinook Salmon

5.4.1.1 Mainstem Hydrosystem Corridor

5.4.1.1.1 Juvenile Migrants. Juvenile SR spring/summer chinook salmon are yearling migrants, with downstream movement during April through June. Although yearling chinook salmon move relatively quickly through the hydrosystem, they have biological requirements for cover and shelter to provide refuge from predators. NOAA Fisheries has demonstrated a strong and consistent relationship between travel time and flow for spring migrants below McNary Dam, where northern pikeminnow predation rates are particularly high (NMFS 2000d). By decreasing the residence time of yearling smolts in the lower river, higher spring flows may reduce exposure time to predators.

One commenter stated that the draft Opinion fails to acknowledge evidence that yearling chinook have inadequate food resources in FCRPS reservoirs to get them through the hydrosystem. While NOAA Fisheries is uncertain to what extent yearling migrants have a biological requirement for food in the juvenile migration corridor, the food requirements for yearling chinook migrants should be similar in both the reference and proposed operations. If they do need food, whether the abundance or composition of the prey assemblage is enhanced or adversely affected by the existence of the reservoirs or their operations is unknown.

They may also experience competition from out-of-ESU hatchery smolts moving through the system during the same period. In addition, hatchery fish may act as a vector for disease transmission in the hydro project bypass and juvenile transport systems.

Biological monitoring shows that the incidence of gas bubble trauma (GBT) in both migrating smolts and adults remains below 1% when total dissolved-gas concentrations in the upper water column do not exceed the Oregon and Washington water quality standard (110%) and gas waiver levels of 120% in tailraces and 115% in forebays. When those levels are exceeded, there is a corresponding increase in the incidence of signs of GBT. High water temperatures (i.e., generally considered to be greater than 68°F) are observed system-wide during late summer and early fall, due in part to thermal storage in project reservoirs (Section 6.2.6.2 in the 2000 Biological Opinion). However, because juvenile and adult SR spring/summer chinook salmon migrate through FCRPS reservoirs before July, this ESU is not subject to these thermal effects.

Because yearling chinook salmon migrate mid-channel through FCRPS reservoirs (Battelle and USGS 2000), they do not have biological requirements for riparian vegetation in the juvenile migration corridor. Further, there is no evidence that the change from a free-flowing river to a reservoir environment has resulted in loss of the amount (i.e., quantity) of physical habitat required by yearling migrants in the migration corridor (Battelle and USGS 2000).

Table 5.1 estimates juvenile in-river survival rates in the reference operation under 1995-2003 water-year conditions for this ESU ranging from about 42% to over 59% (mean 54%). These estimates do not include the effects of latent mortality for in-river migrants. Table 5.1 also estimates the system survival rates, including in-river survival plus transported fish survival, in the reference operation over the 1995-2003 water-year conditions for this ESU ranging from nearly 51% to almost 54% (mean 52.5%). This includes a differential delayed mortality, or D-value, applied to the group of transported fish.

These estimates are lower than estimated survival through free-flowing river sections (Table 5.1). The updated estimate of the mean free-flowing survival from 1995-2003 is 78.6% (Ferguson 2004). This indicates that a significant portion of the mortality of juvenile SR spring/summer chinook can be attributed to the existence and operation of FCRPS dams and reservoirs. Because free-flowing river survival rates are assumed to approximate the survival rate associated with properly functioning habitat conditions (Section 1.2.2.2), the lower survival rates associated with the reference operation indicate that the biological requirements of juveniles have not been fully met within the range of recent runoff conditions and would not be fully met under the reference operation.

5.4.1.1.2 Adult Migrants. Adult SR spring/summer chinook salmon pass up to eight mainstem dams. When adjusted for harvest, average adult survival through the FCRPS, based on recent radio tracking study data from 1996-1998 and 2000-2002, was estimated in Table 5.2 to be 84.6%, with a per-project survival rate of 97.9% (Appendix D, Attachment 4). As described in Section 5.2.2.3.4, this survival rate appears similar to that which would be expected under free-flowing river conditions. Therefore, it is likely that the biological requirements associated with adult migration have been met in recent years and would also be met under the reference operation.

Adult salmon migrating upstream require a sufficient quantity and quality of water to survive to and access the spawning grounds and then spawn successfully. Specific ranges of flow components, velocity, temperature, and turbidity are needed for successful migration. Extremely high water velocities (>13-16 fps) (Corps 1960) can limit adult passage. The preferred temperature range is 7° to 14.5° C (upper and lower lethal limits of 0° and 25° C) (Bell 1991); and high concentrations of dissolved solids can irritate or suffocate salmon. High total dissolved gas supersaturation (TDG) greater than 125% due to involuntary high spill levels during high flow events can impair and reduce survival of migrating adults (Ferguson *et al.* 2004).

Velocity and turbidity extremes that can impair the survival of adult salmon generally do not occur in the mainstem Columbia and lower Snake rivers in the FCRPS. Water temperatures as high as 23° C have been noted in localized surface water areas in the FCRPS, but summer water temperatures in the surface zone (i.e., the upper 15 feet of the water column) generally do not exceed 22° C (DART U. Wash.). Voluntary spill for juvenile fish passage is managed to less than 120% TDG; at this level, no signs of gas bubble disease have been noted, and the effects are considered benign.

SR spring/summer chinook salmon have biological requirements for spawning habitat within the action area, including the Upper Salmon, Little Salmon, and Lemhi subbasins, where USBR has proposed to implement conservation measures.

5.4.1.2 Estuary and Plume Habitat Conditions

The primary factors affecting the status of this stream-type ESU as juveniles move through the lower Columbia River have been avian predation and flow (Fresh *et al.* 2004). Tern predation is primarily directed at yearling-size fish, the dominant life-history strategy for this ESU. These larger juveniles occur in deep water and channels within the estuary where they are most vulnerable to tern predation. Predation affects the abundance and productivity of the affected populations. Flow management for power production, flood control, and irrigation water deliveries has significantly changed mainstem flow patterns from the historical condition, resulting in a decrease in the mean annual flow, a decreased volume, earlier timing of the spring freshet, almost complete loss of overbank flows, and a shift in occurrence from spring to winter. As a consequence of these changes in flow regime, average annual sediment transport has also declined, increasing the visibility and thus vulnerability of migrating smolts to predators. Primarily as a result of flow changes, the shape, behavior, size, and composition of the plume is now different from the way it was before construction and operation of the hydro system. The plume appears to be a rich feeding area for yearling salmonids and may distribute juvenile salmon in the coastal environment, away from predation pressure. Based on the fact that the richest foraging habitat associated with the plume appears to be at the interface between saline and brackish water (Fresh *et al.* 2004), any change in size of the plume could reduce the amount of that habitat. At some level this could result in density-dependent interactions. Also, with a smaller plume, salmon could be in a more confined space and therefore more vulnerable to predators. FCRPS and Canadian hydro storage operations have reduced the size of the plume in June during the period when yearling migrants are making the transition to the ocean phase of their life cycle. This factor may affect viability, although there is no empirical information at this time.

5.4.1.3 Tributary Habitat Conditions

The action area for Snake River spring/summer chinook includes all tributary subbasins to which adult fish return and therefore are potentially affected by a reduction of marine-derived nutrients. In three of these subbasins the Action Agencies propose conservation measures as part of their Updated Proposed Action. Conditions in the tributary subbasins where conservation actions will occur are described in the following subsections. These three subbasins are generally representative of conditions in the remaining subbasins with similar habitat and land use. Appendix E, the Limiting Factors Analysis prepared to guide the development of the UPA further informs this evaluation of the environmental baseline in the tributary habitat. The subbasins occupied by this ESU in addition to those discussed below are evaluated in Appendix E. For the purposes of this biological opinion, the effects of these representative subbasins, described below, are extrapolated to all subbasins.

5.4.1.3.1 Little Salmon River (USGS HUC 17060210). The Little Salmon River, approximately 43 miles long, enters the main Salmon at RM 82. The Little Salmon River subbasin includes a total of 372,500 acres, and the Payette National Forest manages approximately 11% (40,975 acres) of the area. The USFS lands (Payette and Nez Perce National forests) make up the majority of the subbasin, followed by private, BLM, and state lands. The upper half of the watershed is in a wide valley surrounded by forested mountain slopes. The valley is characterized as pasture and meadowlands, with the Little Salmon River meandering through the valley.

A large variety of past and present land uses have impacted listed species habitat to varying levels. Human activities in the subbasin include logging, roads, trails, water withdrawal, agriculture, livestock grazing, residences, communities, and recreation. The higher-elevation lands administered by the USFS have been used for timber harvest, livestock grazing, and recreation. The BLM lands within the subbasin have also been used in a manner similar to USFS lands, which is primarily for timber harvest and livestock grazing. Major subwatersheds in the Little Salmon River include Rapid River, Elk Creek, Boulder Creek, Hazard Creek, Hard Creek, Round Valley Creek, and Goose Creek. U.S. Highway 95 parallels the Little Salmon River and encroaches on riparian areas and floodplains in the lower canyon reach. Several small towns are in the subbasin, ranging in size from a few hundred people to slightly more than one thousand. The predominant uses on Payette National Forest lands include roads and timber harvest (BRT 2003).

The watersheds within this subbasin have been degraded from their historical conditions and are believed to be limiting for spring/summer chinook because of flow, altered channel morphology, temperature, and the lingering effects of past grazing, roads, and forestry practices. The lack of a properly functioning riparian corridor in the Little Salmon River has affected stream temperatures and the structure of the channel due to a lack of LWD recruitment. (NWPPC 2004b) Water has been diverted for numerous purposes, homes have been built near the high-water mark, and most tributaries are inaccessible. State Highway 55 constricts channel migration.

NOAA Fisheries reviewed the relevant records of completed consultations for this subbasin and found 24 Federal actions in the Little Salmon subbasin (USGS HUC 17060210). These actions addressed herbicide and insecticide applications; culvert, road, and bridge repair and removals; and special use permits for grazing, cemeteries, phone lines, guide services, and bridges, with varying short- and long-term effects on passage, instream flow and riparian condition.

The Corps completed consultation on a number of non-restoration actions focused on roads. These included debris slide remediation, extension and repair of four culverts, and road widening. The Corps also completed consultation on the repair of a velocity barrier at the Rapid River Fish Hatchery.

Other Federal agency consultations included an FHWA road repair and bridge repair on different tributaries of the Little Salmon. BLM completed consultation on continuing localized herbicide applications. The FS completed a number of consultations which were generally small actions distributed widely over the Little Salmon. These small actions included maintenance of recreational facilities, hazardous tree removal, localized application of insecticide and special use permits for telephone lines, bridge use, and cemetery maintenance. Larger scale consultations included one emergency fire suppression action and an associated salvage project, special use permits for sheep grazing and fish guides all with minimal effects on listed salmonids. The FS completed consultation on expansion of a ski slope area and proposed and ongoing program actions.

Based on this review, the consulted-upon Federal actions will have slight effects, both adverse and beneficial, to factors limiting listed salmonids at the reach scale in the Little Salmon subbasin.

5.4.1.3.2 Lemhi (USGS HUC 17060204). The Lemhi River watershed drains approximately 1,260 square miles between the Beaverhead Range on the north and east sides and the Lemhi Range on the west. Elevations range from 4,100 feet above mean sea level (amsl) at the confluence with the Salmon River one mile north of the town of Salmon to over 11,000 feet amsl. Average annual precipitation ranges from 7 inches at lower elevations to 23 inches in the mountains. Most of the land immediately adjacent to the Lemhi River and its major tributaries is in private ownership. The Bureau of Land Management (BLM) manages the land at the mid-elevations, and the US Forest Service (USFS) manages the high-elevation forests. State-owned lands are scattered throughout the basin (USDI-BLM 1999).

The Lemhi River is a low-gradient, spring-fed system. The hydrology has been changed dramatically in the last 150 years, beginning with beaver and beaver dam removal and more recently with extensive irrigation withdrawals and channel alterations. All tributaries except Hayden Creek and Big Springs Creek are seasonally dewatered and no longer reach the mainstem Lemhi during the irrigation season (April to October) (USDI-BLM 1999).

The watersheds within this subbasin have been degraded from their historical conditions and are believed to be limiting for spring/summer chinook because of flow, altered channel morphology, temperature, water quality, and the lingering effects of grazing and agricultural practices which cause an increase in sedimentation. The hydrologic regime (peak flows, base flows, flow timing)

and connectivity of most Lemhi tributaries have been altered by irrigation withdrawals. Only 7% of all tributaries remain connected to the mainstem. These changes limit the access of resident and anadromous populations to potentially available habitat and delay anadromous smolt and adult migration in the lower reaches of the mainstem Lemhi, which contributes to increased mortality rates (NWPPC 2004b).

Currently, fish passage through the lower portion of the river has been impaired by low water conditions and structures associated with irrigation diversions. In 2001, the Idaho Office of Species Conservation, Idaho Department of Water Resources, Idaho Department of Fish and Game, NOAA Fisheries, USFWS, the Lemhi Irrigation District, Water District 74, and the Upper Salmon Basin Watershed Project entered into an agreement (Lemhi Agreement) that, among other things, provides stream flows sufficient for fish passage between the L6 diversion and the mouth of the Lemhi River. This is done through a combination of landowner agreements and annual water leases that are still being refined. In addition to the Lemhi Agreement, the USBR is pursuing several diversion improvements to comply with the 2000 FCRPS Biological Opinion (NMFS 2000a). Together, these activities should improve passage in the lower river, which has adversely impacted upstream and downstream migrants. In addition, the Upper Salmon River Watershed Project is actively working with landowners to improve riparian habitat on private land. A comprehensive listing of past and current restoration efforts in the Lemhi can be found in the 2002 Lemhi Agreement (IOSC *et al.* 2002; NOAA Fisheries 2002)

NOAA Fisheries' reviewed the relevant records of completed consultations for this subbasin and found 13 completed formal and informal consultations covering actions in the Lemhi subbasin (USGS HUC 17060204). These actions addressed herbicide applications, water diversion modification, culvert replacement, bridge replacement, and water leases with varying short- and long-term effects on passage, instream flow and riparian condition.

BPA completed consultation on the Mill Creek Pipeline project, which repaired a section of irrigation pipe and stabilized associated sections of stream bank in a tributary to the Lemhi River. In the Lemhi River, BPA proposed to transfer point of use for some Lemhi irrigators from the Lemhi (L6) to the mainstem Salmon (S14). This action, which could increase flows for a portion of the Lemhi to benefit listed salmonids, has experienced delays in implementation. BPA also completed Lemhi River Diversion Replacement L3A. This action will improve passage for all life stages of resident and anadromous fish species in this section of the Lemhi by removing an existing push-up dam and install three "v"-shaped rock weirs. Replacing the push-up berm with a permanent structure will improve conditions for upstream and downstream migrating fish by eliminating annual instream maintenance, improving water quality conditions, creating step pools, increasing flow over the new structures, reducing the amount of water diverted out of the river, and creating a defined channel.

USBR completed a consultation to lease water in the Lemhi to provide increased flows for rearing, passage and improved water quality. The Corps completed consultation on an action to replace a small wooden bridge and rock ford with a railcar bridge.

Other Federal agency consultations included an FHWA Basin Creek action to replace an existing bridge. This project is expected to have long-term positive effects on SR spring/summer chinook

salmon and SR steelhead through extensive riparian plantings and floodplain restoration. BLM completed consultation on a project in Basin Creek to repair a culvert and improve road surfaces to increase fish passage and reduce adverse impacts to water quality. The FS completed two consultations on actions to apply herbicides to small numbers of acres in the Lemhi. These actions were not expected to reduce survival to listed salmonids. NOAA Fisheries completed consultation on funding a point of diversion screen in the Lemhi to reduce salmonid mortality.

Based on this review, the consulted-upon Federal actions will have an overall beneficial effect on the factors limiting listed salmonids at the reach scale in the Lemhi subbasin.

5.4.1.3.3 Upper Salmon River (Salmon River and tributaries upstream of the confluence of the Pahsimeroi River) (***USGS HUC 17060201*****).** Most of the Upper Salmon River is a transport system. The Stanley basin and Round Valley are the most important response reaches because of their large floodplains. The river has been crowded to one side of Round Valley, probably to add space for ranching and irrigated agriculture in the early 20th century. Residents upstream of and within the area have constructed numerous flood-prevention structures (i.e., dikes, gravel removal from the channel bed, etc.) to protect their property. Based on site observations and air photo interpretation, the Corps believes that the alignment of the channel has been grossly altered by these activities (Higginbotham 2003). The change in alignment, loss of stabilizing riparian vegetation, and sediment load from upstream have caused instability in the channel, with roughly 70% of the banks showing evidence of active erosion. The channel lacks the distribution of riffle and pool habitat (roughly 50% of each) that is preferred for salmonid rearing. The existing Upper Salmon River is largely run (glide) habitat, with a small amount of riffle habitat. There are only 5 to 10 square meters of high quality pool habitat in the project area. The geomorphic changes and intensity of irrigation withdrawals have resulted in some river segments having inadequate surface flows during the irrigation season. The channel lacks large woody debris that is correlated with the low level of existing riparian vegetation. Large wood may have been removed by landowners to prevent possible flooding of their property or by rafting guides to eliminate safety hazards, and it is moved naturally during high water events. There is little instream diversity and instream cover (less than 5%).

Upper Salmon River water quality is relatively high. Some streams have sediment and high concentrations of nutrients and metals, particularly in watersheds where improper road construction, mining, and livestock grazing have occurred (USRITAT 1998). The Salmon River corridor was included in the IDEQ 303(d) water quality-impaired list in 1998 because of polluted sediments and high temperatures from Redfish Lake Creek downstream to the East Fork Salmon River. Major streams that flow into the Salmon River within the USRC area include Morgan Creek, Challis Creek, and Garden Creek from the west and Pennal Gulch from the east (BRT 2003).

The watersheds within this subbasin have been degraded from their historical conditions and are believed to be limiting for spring/summer chinook because of flow, altered channel morphology, and the lingering effects of past grazing activities. The natural hydrologic regime in the Upper Mainstem Salmon (from the East Fork confluence to the headwaters) has been altered by streamflow withdrawals. The effects from these pressures include a reduction in base flow conditions and some modifications in flow timing (NWPPC 2004b). Sedimentation from various

land use activities has impacted habitat quality and quantity in the mainstem from the East Fork confluence to the headwaters (NWPPC 2004b). Roads, timber harvest, grazing, and changes to the hydrologic regime of the small Upper Salmon tributaries have acted alone or cumulatively to contribute excess amounts of fine sediment to channels (NWPPC 2004b).

NOAA Fisheries' reviewed the relevant records of completed consultations for this subbasin and found 10 completed formal and informal consultations in the Upper Salmon subbasin (USGS HUC 17060201). These actions addressed herbicide applications, water diversion modification, culvert replacement, road realignment, bridge replacement, and proscribed burns with varying short- and long-term effects on passage and instream flow.

BPA completed consultation on the East Fork of the Salmon River (SEF) Diversions – projects SEF 10, 11, and 12. The action consolidated points of diversion, reduced head cutting actions in the river at SEF 10 by eliminating an instream push-up diversion berm, replaced the existing SEF 11 and 12 push-up gravel berms that impeded anadromous fish passage and required regular mechanized instream maintenance and repair with a permanent rock weir that also spanned the East Fork. The project should help improve rearing and fish passage habitat and protect downstream spawning and in-gravel nursery habitat and may increase survival of SR spring/summer chinook salmon and SR steelhead.

The Corps consulted on the Salmon River at Challis Project (USRC), which will restore the riparian function of the floodplain, the geomorphic function of the river channel, and the fluvial salmonid habitat. The project would specifically benefit SR steelhead, and to a lesser extent, SR spring/summer chinook salmon, by improving a variety of habitat components in the 12-mile reach of the Upper Salmon River drainage. The USRC project site covers a small portion of the watershed and NOAA Fisheries expects only short-term negative effects on salmonid habitat. Implementing the project to meet the goals of restoring river ecosystem function and improving fish habitat, the USRC will have a long-term positive effect.

The Corps consulted on single culvert replacement projects in different tributaries in this subbasin. NOAA Fisheries (Pacific Coast Salmon Recovery Fund) consulted on replacing an existing push-up gravel dam with a permanent rock weir. The weir will protect juvenile rearing habitat that is provided by a natural overflow channel, and improve holding and passage conditions.

Other consultations included culvert repair, herbicide or pesticide applications, or proscribed fires over small areas by BLM and the FS, which had insignificant adverse effects on listed salmonids, and small road realignment and stream restoration projects completed by the FS which resulted in long-term positive effects on habitat conditions.

Based on this review, the consulted-upon Federal actions will have a generally positive effect on the factors limiting listed salmonids at the reach scale in the Upper Salmon subbasin.

5.4.1.3.4 Salmon River, Mainstem (downstream from East Fork). The watersheds within this subbasin have been degraded from their historical conditions and are believed to be limiting for spring/summer chinook because of flow, altered channel morphology, and the lingering effects

of past grazing, agricultural and road building and maintenance practices. Habitat in the mainstem between the confluences of the North Fork Salmon and Pahsimeroi Rivers has been primarily limited by a modified hydrologic regime, inadequate pool:riffle ratios, and structural migration barriers (NWPPC 2004b). The natural hydrologic regime in the Upper Mainstem Salmon (from the East Fork confluence to the headwaters) has been altered by streamflow withdrawals. Sedimentation from various land use activities has impacted habitat quality and quantity in the mainstem from the East Fork confluence to the headwaters (NWPPC 2004b). The lingering effects of diversion of water for irrigation and its subsequent return, combined with reductions in riparian shading, has represented the primary factors contributing to increased temperatures in the mainstem Salmon from the 12-mile section upstream to Challis (NWPPC 2004b). Channel confinement and development of riparian areas, from the 12-mile section upstream to the headwaters, have caused a reduction in the pool:riffle ratio, a reduction in streambank stability, and a reduction in shade, and there is limited salmonid access to side channel habitat (NWPPC 2004b).

5.4.1.4 Harvest Rates

As indicated above, in order to estimate the extent of the baseline treaty harvest, NOAA Fisheries will presume that treaty and non-treaty harvest rates comparable to the current harvest rates will continue into the future pursuant to Court-approved settlement agreements. Mainstem harvest rates for SR spring/summer chinook salmon are set forth in the 2001 Interim Agreement on winter/spring/summer fisheries (Table 5.3). Allowable harvest rates in mainstem fisheries (primarily between the river mouth and McNary Dam) vary depending on run size, between 5.5 and 17%. Actual harvest rates have ranged between 5 and 15% over the last five years (Appendix C). Harvest rates expected to occur in the action area in the next few years are shown in Table 5.3. Fisheries in the Snake River and its tributaries have been closed for more than 20 years (except for fisheries harvesting non-listed fish in the Little Salmon and Clearwater rivers). Fisheries on surplus, hatchery-origin fish have been covered under ESA Section 10 permits since 2001.

5.4.1.5 Artificial Propagation Programs

Future artificial propagation operations as described in Section 5.3.5 are part of the environmental baseline.

5.4.2 Snake River Fall Chinook Salmon

5.4.2.1 Mainstem

Juvenile SR fall chinook salmon are subyearling migrants, moving downstream during June through September and rearing during at least part of this period. High water temperatures are observed system-wide during summer and early fall and the survival of juvenile fall chinook

through Lower Granite Reservoir may be reduced by an interaction between the thermal effects of hydro operations and Idaho Power Company's operations at its Hells Canyon Complex.[6]

Subyearling fall chinook salmon in the lower Snake River reservoirs are either pelagic-oriented or found over sandy, mostly unvegetated substrate. It is uncertain whether subyearlings have biological requirements for cover, shelter, and vegetation (beyond the potential effect of mainstem flow as a refuge from predation). Although the prey resources available to subyearling SR fall chinook in mainstem reservoirs are different than those in free-flowing reaches (e.g., terrestrial insects and zooplankton dominate in reservoirs versus aquatic insects in a free-flowing river), NOAA Fisheries is uncertain whether this change enhances or adversely affects biological requirements for food during the outmigration. Similarly, water level fluctuations associated with reservoir operations could disrupt the life cycles of invertebrate prey in the littoral zone, but the Corps operates the lower Snake River pools within one foot of minimum operating pool, minimizing effects on shallow water habitat.

The existence of mainstem FCRPS reservoirs and USBR operations interact with effects of operations at the Hells Canyon Complex to increase water temperatures in the lower Snake River from mid-July through mid-September. In response to a comment on the September 2004 draft of this Opinion, NOAA Fisheries concurs that the existence of Snake River FCRPS reservoirs contributes to a shift in the temperature regime of the Snake River by delaying cooling into mid-September due to the large volumes of impounded warm water. Adults entering the Snake River during this period can be delayed by elevated water temperatures, potentially reducing fish condition and fecundity during spawning. Fall chinook salmon are known to spawn in the tailraces of Lower Granite, Little Goose, and Ice Harbor dams. Spawning may be inhibited at temperatures above 61°F (16°C). The effects of flow management on the use of mainstem spawning habitat (water quantity and velocity, space, access to habitat, and availability of suitable substrate) are unknown.

Survival of PIT-tagged juvenile fall chinook salmon from release points in the Snake and Clearwater rivers to Lower Granite Dam is strongly correlated with water temperature, as well as flow and turbidity, in Lower Granite Reservoir (Williams *et al.* 2004). To minimize water temperature-related effects on juvenile and adult fall chinook, Dworshak Dam on the North Fork Clearwater, about 2 river miles upstream of the Clearwater River and 60 miles from Lower Granite Reservoir, is routinely operated to release large amounts of cool water during the months of July, August and early September to reduce water temperatures in Lower Granite Reservoir and downstream reaches to try to achieve State of Washington water temperature standard of 20 C. Dworshak Reservoir is a deep impoundment (over 600 feet at full pool) that stratifies in the summer, and Dworshak Dam is equipped with a variable-intake depth-release structure that facilitates selecting a specific discharge water temperature. During July, August and in recent years into September, reservoir managers typically release water between 45° to 50°F (7° to 10°C) at the request of regional salmon managers. This operation, which is included in the reference operation and hence included in the environmental baseline, reduces ambient water

[6] The Hells Canyon Complex is outside the action area for this consultation. Nevertheless, as a conservative assumption, this consultation considers these existing conditions in that portion of the action area immediately adjacent to this project.

temperature by approximately 4° to 6° F (-2° to -3°C) at Lower Granite Dam when elevated temperatures are a concern in the Snake River (July through mid-September).

5.4.2.1.1 Juvenile Migrant Survival Rates Estimates of juvenile in-river survival rates in the reference operation during 1995-2003 (no survival estimates are available for 1994 or 2002 for this ESU) range from nearly 10% to over 24%, with a mean of 17.0% (Table 5.1). These estimates do not include possible effects of latent mortality for in-river migrants. As described in Section 5.2.2.3.1.2, these estimates are lower than estimated survival through free-flowing river sections (Table 5.1). This indicates that a significant portion of the mortality of juvenile SR fall chinook can be attributed to the existence and operation of FCRPS dams and reservoirs. Because free-flowing river survival rates are assumed to approximate the survival rate associated with properly functioning habitat conditions (Section 1.2.2.2), the lower survival rates associated with the reference operation indicate that biological requirements of juveniles have not been fully met in recent years and would not be fully met under the reference operation.

5.4.2.1.2 Adult Migrant Survival Rates. Adult SR fall chinook salmon pass up to eight mainstem dams. When adjusted for harvest, average adult survival is 84.7%, with a per-project survival rate of 98.0% (Table 5.2). As described in Section 5.2.2.3.4, this survival rate appears similar to that which would be expected under free-flowing conditions. Therefore, it is likely that biological requirements associated with adult migration have been met in recent years and would also be met under the reference operation.

5.4.2.2 Estuary and Plume Habitat Conditions

Many SR fall chinook appear to enter the estuary as chronological subyearlings. Most migrate to sea in their first year of life, but because of their long (in-river) transit time, probably continue to grow and reach the estuary at a larger size than chronological subyearlings from lower Columbia basin ESUs. Upper basin subyearlings appear to use habitat in the upper estuary, continuing to grow as they transition to brackish and then salt water. Tern predation has a low effect on this ESU; apparently terns do not target smaller chinook or chum salmon. Toxics, both water- and sediment-borne, can affect these life history strategies if they occur in occupied shallow-water areas.

5.4.2.3 Tributary Habitat Conditions

This is primarily a mainstem-spawning ESU, as discussed in Section 4.3.2.1, with limited spawning in the lower sections of the major tributaries whose conditions are similar those of the adjacent mainstem habitat discussed above. In addition to these mainstem areas in the action area that are directly affected by the FCRPS, the reach of the Snake River upstream from the Salmon River to the Hells Canyon Dam is also in the action area due to the potential indirect effects of reduced marine-derived nutrients. The action area also includes several subbasins likely to be affected by the Action Agencies' proposed hatchery offsetting measure for effects of the hydrosystem on Snake River fall chinook for spawning. Conditions in these tributary subbasins are described in the following subsections. Appendix E, the Limiting Factors Analysis, prepared to guide the development of the UPA, further informs this evaluation of the environmental baseline in the tributary habitat. The subbasins adjacent to the mainstem habitat and occupied by

this ESU, including the unimpounded reach of the Snake River below Hells Canyon Dam, are also evaluated in Appendix E and incorporated by this reference.

5.4.2.3.1 Middle Fork Clearwater (HUC 17060304). Elevations in this subbasin range from about 2,300 feet in the western portions along the mainstem Clearwater River to about 4,300 feet in the easternmost portions. The change in elevation follows a change in topography from west to east, progressing from plateau to foothills to mountainous terrain. Climatic conditions vary with changes in elevation and terrain, with annual precipitation increasing from roughly 25-75 inches on a west to east gradient.

Land ownership is highly mixed and comprised of private, state, federal and tribal holdings. Potlatch Corporation and the Idaho Department of Lands manage substantial portions of the land, and properties managed by these two entities are highly intermixed. The eastern- most portion of is federally owned and managed by the U.S. Forest Service. Private holdings are an important component in the western half of the subbasin, which are also interspersed by Nez Perce Tribal lands. Less than 10 percent of the land area is afforded any protected status, with the majority of that being inventoried roadless area. Land cover is primarily forest, with agricultural use limited to portions of the western plateaus. Much of the forested area has been intensively harvested in the past, a fact reflected in the high densities of forest roads through much of the subbasin. Subwatershed-scale road densities exceed 5 miles/sq. mile through much of the subbasin, and in some areas exceed 7.5 miles/sq. mile.

Substantial numbers of mining claims are present on federal and state lands throughout the subbasin. Mines have been located throughout the subbasin. Numerous mines located in the headwaters of Orofino Creek have had substantial impacts on water quality.

Major factors limiting fish populations within the subbasin include temperature, sediment, and upland and instream habitat disturbance or degradation from the lingering effects of management actions.

5.4.2.3.2 South Fork Clearwater River (HUC 17060305). The South Fork Clearwater River subbasin is approximately 746,000 acres in size. Elevations range from 1,240 feet at the mouth to 10,000 feet, and precipitation ranges from 10 to 30 inches per year, evenly distributed throughout fall, winter, and spring. Winter precipitation is mostly snow, and summers are relatively dry. This area is characterized by loess plains, hills with large steptoes, and some river breaklands. Loess plains have low to medium density branching drainage patterns. The bedrock geology is predominantly Columbia River basalt and, to a lesser extent, quartz dioritic gneiss. Rapid changes in runoff volumes are possible on basalt due to gain or loss of water from gravel lenses. Land use includes dry farming and livestock grazing on about 90% of the area. Canyon grasslands are in poor ecological condition and are generally heavily infested with noxious weeds, particularly yellow starthistle.

The mainstem South Fork Clearwater River begins at the confluence of American and Red rivers. From this point to about Tenmile Creek, the mainstem is a relatively low gradient riffle/pool stream dominated by gravel and cobble substrate (USDA 1998). It has been highly altered by dredge mining and the placement of State Highway 14. From Tenmile Creek to Mill

Creek, the mainstem is steeper, more confined, and the substrate is dominated by boulders and cobbles. Sediment is readily transported through this high-energy reach. From Mill Creek to just above Threemile Creek to its confluence with the Middle Fork Clearwater River at Kooskia, the South Fork is a relatively flat, unconfined riffle/pool channel with gravel and cobble substrate. This lowest reach of the river has also been partially confined by dikes, most notably in the vicinity of Stites and Kooskia, Idaho.

The lower South Fork Clearwater River below Farrens Creek (RM 24.5; USFS boundary) has been affected to various degrees by aggradation, channelization, diking, riparian vegetation removal, and encroachment by developments, such as roads and buildings (USDA 1998). State Highway 14 parallels the river and has encroached on riparian areas and channels. Aggradation of the river is associated with bedload from upstream sources, but most noticeably from the major Camas Prairie tributaries (e.g. Butcher, Threemile, and Cottonwood creeks) and local bank erosion. In the unconfined reaches, the net result is a channel that is wider and shallower and with fewer large pools than existed under natural conditions. Fish habitat has been degraded through a reduction in cover and water depth and through an increase in sediment deposition and summer water temperatures. In some years, much of the lower South Fork has become unsuitable for cold water fishes due to warm water temperatures (USDA 1998). The South Fork Clearwater River, Butcher Creek, Cottonwood Creek (mainstem and South Fork), Red Rock Creek, Stockney Creek, and Threemile Creek are currently listed as 303(d) Water Quality Limited Segments under the Clean Water Act.

Physical characteristics of the subbasin have been altered by agriculture, residential and commercial developments, livestock grazing, timber harvest, roads, and recreation. Floodplain development has occurred on private lands, and numerous communities are present in the Lower South Fork Clearwater River subbasin. Steelhead migration in the Clearwater River basin upstream from Harpster, Idaho, was completely blocked by the Harpster dam from 1910 to 1935 and from 1949 until 1963, when the dam was removed (Cramer *et al.* 1998). The Lewiston dam that existed on the mainstem Clearwater River from 1927 to 1974 had marginal fish passage from 1927 to 1939 due to a poorly constructed fish ladder. An improved fish ladder was installed in 1939, and many steelhead have been able to pass over the dam after this time (Cramer *et al.* 1998).

Primary fall chinook use within the Clearwater River subbasin is downriver from the North Fork of the Clearwater River (RM 40.5). Steelhead use the mainstem South Fork Clearwater River as a juvenile and adult migration corridor. The mainstem South Fork Clearwater River is also used for adult overwintering, juvenile rearing, and to a limited extent for spawning. Primary spawning and rearing occurs in South Fork Clearwater River tributary streams. Spring/summer chinook salmon use the mainstem South Fork Clearwater River as a juvenile and adult migration corridor. The mainstem South Fork Clearwater River is also used to a limited extent for juvenile rearing. Spring chinook spawning and rearing occurs primarily in larger tributary streams upriver from the USFS boundary.

5.4.2.3.3 Clearwater (HUC 17060306). The Clearwater River subbasin includes the mainstem Clearwater River and tributaries accessible to anadromous fish below the South Fork Clearwater River confluence. This subbasin includes a total of 1,497,000 acres. BLM lands within the

subbasin total 21,340 acres (one percent). USFS lands total 136,000 acres (nine percent). The majority of the ownership in the subbasin is private. Other ownership in the drainage includes Idaho Dept. of Lands, Nez Perce Tribe, Corps of Engineers, and Idaho Fish and Game. The Clearwater River flows into the Snake River at Lewiston, Idaho, and Clarkston, Washington.

Elevations within the subbasin range from 700 feet at the mouth of the Clearwater River to 5,810 feet in the headwaters of Lolo Creek. The Clearwater River flows through a canyon that is 2,000 to 3,000 feet deep. The adjacent plateaus or uplands are rolling and moderately sloped, and are primarily agricultural areas. Higher elevation areas in the subbasin are forested. Private land uses include agriculture, timber harvest, livestock grazing, recreation, roads, urban development, and residences. Potlatch Corporation, a private timber company, has significant land ownership in the upper Potlatch and Lolo Creek watersheds. Scattered Nez Perce Tribal lands also occur throughout the subbasin. The USFS lands are limited to blocks in the upper Potlatch, Lolo, and Orofino Creek watersheds. The BLM lands within the subbasin are scattered and generally comprise only a small percentage of any watershed. Land uses on BLM lands primarily include timber harvest, livestock grazing, roads, and recreation. Many streams in this subbasin no longer support anadromous fish, and have been severely altered by roads, farming, housing development, streamside grazing, and small water withdrawals.

The Nez Perce Tribe has been active in recent introductions of fall chinook salmon and coho salmon within the subbasin. The mainstem Clearwater River is used as an upstream and downstream passage corridor by fall chinook salmon, steelhead, spring/summer chinook salmon, and coho salmon. Fall chinook salmon use the mainstem Clearwater River for spawning and rearing. Steelhead are dispersed throughout this hydrologic unit, and use most accessible tributaries for spawning and rearing. Elevated water temperature, sediment deposition and low streamflows in the summer and fall limit salmon and steelhead use of many streams in this subbasin. Spring/summer chinook salmon and steelhead use the mainstem river, to a very limited extent, for spawning and rearing.

5.4.2.3.4 Lower North Fork Clearwater (HUC 17060308). With the exception of the lower 1.9 miles of the mainstem North Fork Clearwater River, passage of anadromous species in this subbasin is completely blocked by Dworshak Dam. Dworshak Reservoir is located entirely within this subbasin. The construction and operation of Dworshak Reservoir on the lower North Fork Clearwater River has altered the baseline thermograph of the lower Snake River since about 1973. Before 1984 cooler flows from Dworshak Dam were limited with discharge less than 4 kcfs; however, since 1985 summer releases during average to wet flow years range between 6 to 20 kcfs. The highest summer flow releases were made since 1993, and have actively been used to mitigate warming of LGR and the lower Snake River. The frequency and duration of releases depend upon operational plans and storage volume of Dworshak Reservoir. Limitations to this ESU in this area are primarily related to dam operations resulting in highly variable flows and fluctuating water levels (NOAA Fisheries 2004).

5.4.2.4 Harvest Rates

As indicated above, in order to estimate the extent of the baseline treaty harvest, NOAA Fisheries will presume that treaty and non-treaty harvest rates comparable to the current harvest

rates will continue into the future pursuant to Court-approved settlement agreements. Mainstem harvest rates for SR fall chinook salmon are set forth in the 2004 Fall Agreement (Table 5.4). Ocean and mainstem Columbia River fisheries can harvest Snake River fall chinook up to the rate of 45-50% (i.e., total exploitation rate). For the last several years, mainstem fisheries have been managed subject to a 31% harvest rate limit. This represents a 30% reduction in the harvest rate observed during the 1988-1993 base period. The actual harvest rate has ranged between 21 and 31% over the last five years (Appendix C). Fisheries for fall chinook in the Snake River and its tributaries have been closed for more than 20 years. Harvest rates expected to occur in the action area in the next few years are shown in Table 5.4.

5.4.2.5 Artificial Propagation Programs

Future artificial propagation operations as described in Section 5.3.5 are part of the environmental baseline.

5.4.3 Upper Columbia River Spring Chinook Salmon

5.4.3.1 Mainstem

5.4.3.1.1 FCRPS Projects. Juvenile UCR spring chinook salmon are spring migrants with peak movement past Rock Island Dam in the mid-Columbia reach during late April and May. The status of biological requirements for this ESU related to mainstem habitat and in the estuary and plume, and potential interactions with out-of-ESU hatchery fish, are the same as those discussed for SR spring/summer chinook salmon (Section 5.4.1).

For the reference operation (see Table 5.1), NOAA Fisheries estimated that juvenile in-river survival through the lower Columbia River reach ranged from 60% to nearly 77% under 1994-2003 water-year conditions, with a mean value nearly of over 71% (Appendix D). These estimates do not include an effect of latent mortality for in-river migrants.

These estimates are lower than estimated survival through free-flowing river sections (see Table 5.1). The updated estimate of the mean free-flowing survival from 1995-2003 data is 85.5% (Ferguson 2004). This indicates that a significant portion of the mortality of UCR spring chinook can be attributed to the existence and operation of FCRPS dams and reservoirs. Because free-flowing survival rates are assumed to approximate the survival rate associated with properly functioning habitat conditions (see Section 1.2.2.2), the lower survival rates associated with the reference operation indicate that biological requirements of juveniles have not been fully met within the range of recent water years and would not be fully met under the reference operation.

Average adult survival estimated in Table 5.2 from recent (2000-2002) radio-tracking studies is 92.0%, with a per-project survival rate of 97.9% (Appendix D, Attachment 4). As described in Section 5.2.2.3.4, this survival rate appears similar to that which would be expected under free-flowing river conditions. Therefore, it is likely that the biological requirements associated with adult migration have been met in recent years and would also be met under the reference operation.

5.4.3.1.2 Habitat Conservation Plans for FERC-licensed Projects in the Mid-Columbia Reach. NOAA Fisheries completed ESA Section 7(a)(2) consultations on its issuance of incidental take permits to Douglas and Chelan County Public Utility Districts in support of the proposed Anadromous Fish Agreements and Habitat Conservation Plans (HCPs) for the Wells, Rocky Reach, and Rock Island hydroelectric projects in the mid-Columbia reach on August 12, 2003. Under the HCPs, Douglas and Chelan County PUDs have agreed to use a long-term adaptive management process to achieve a 91% combined adult and juvenile survival standard for each salmon and steelhead ESU migrating through each project. In addition, compensation for up to 9% unavoidable project mortality is provided through hatchery and tributary programs, with compensation for up to 7% mortality provided through hatchery programs and compensation for up to 2% provided through tributary habitat improvement programs.

In the HCP biological opinions, NOAA Fisheries found it reasonable to expect that project-related deaths (i.e., direct, indirect, and delayed mortality resulting from project effects) for juveniles of each species migrating through each project would be equal to, or less than 7% throughout the term of the HCPs. In addition, NOAA Fisheries found that total (natural and project-related) mortalities of adults migrating upstream through each project currently range from approximately 2 to 4%. Taking into account natural mortality, NOAA Fisheries found that the HCP standard of no more than 2% adult mortality resulting from project-related effects was probably met for each species at this time. Thus, NOAA Fisheries estimated that the total measurable lethal take of adults would be no more than 4% using the methods adopted in the biological opinion until such time that technologies allow for a reasonable differentiation of these sources of mortality. At that time, allowable project-related lethal take shall not exceed 2% for any species.

In May 2004, NOAA Fisheries also completed an ESA Section 7 consultation on FERC's proposed amendment to the existing license for the Grant County PUD Priest Rapids Hydroelectric Project, which permitted implementation of an interim protection plan, including interim operations for Wanapum and Priest Rapids dams. Under this biological opinion and incidental take statement for the Priest Rapids Hydroelectric Project, NOAA Fisheries expects that project-related mortalities (i.e., direct, indirect and delayed mortality resulting from project effects) for both hydro projects combined will not exceed 24.5% for juvenile UCR spring chinook salmon and will not exceed 23.2% for juvenile UCR steelhead. These estimates are the average estimated mortality derived from recent (1999-2003) survival studies. NOAA Fisheries also expects that implementation of the interim protection plan will result in mortality rates of no more than 2% per project, or 4% combined, for adult UCR spring chinook salmon and 3% per project, or 6% combined, for upstream migrating adult UCR steelhead.

Thus, the cumulative mortality effect of passage through all five mid-Columbia PUD hydroelectric projects on juvenile UCR spring chinook is expected to be approximately 39%, and for juvenile UCR steelhead, the combined mortality of passage through all five mid-Columbia PUD projects is expected to be less than about 38%. The total mortalities (natural and project-related) of adult UCR spring chinook salmon migrating upstream through all five mid-Columbia PUD projects is expected to range between 9.6% and 15%, with total mortalities for UCR steelhead passing all five projects expected to range between 11.4% and 16.8%.

5.4.3.2 Estuary and Plume Habitat Conditions

The status of the habitat in the estuary and plume for this yearling-type ESU is the same as that described for SR spring/summer chinook salmon (Section 5.4.1.2).

5.4.3.3 Tributary Habitat Conditions

The action area for Upper Columbia River spring chinook includes all tributary subbasins to which adult fish return and therefore are potentially affected by a reduction of marine-derived nutrients. In three subbasins the Action Agencies proposed conservation actions as part of their Updated Proposed Action. Conditions in the tributary subbasins where conservation actions will occur are described in the following subsections. These three subbasins are generally representative of conditions in the remaining subbasins with similar habitat and land use. Appendix E, the Limiting Factors Analysis, prepared to guide the development of the UPA, further informs this evaluation of the environmental baseline in the tributary habitat. The subbasins occupied by this ESU in addition to those discussed below are evaluated in Appendix E. For the purposes of this biological opinion, the effects of these representative subbasins, described below, are extrapolated to all subbasins.

5.4.3.3.1 Methow (USGS HUC 17020008). The Methow basin, including the Chewuch watershed, is dominated by glacial outwash sands and decomposed granitic parent material. Sand is a major component of the channel and bank substrate. Highly erosive soils are common and occur in both wilderness and non-wilderness reaches (USFS 1998). Glacial deposits of sands and gravels make up the principal Methow Valley aquifer. These substrates are so porous and permeable that a high degree of hydraulic continuity is virtually guaranteed as the groundwater and surface water exchange rapidly under certain conditions (Peterson and Larson 1991). For example, snow melt in the spring creates high flow levels in the Methow River which caused water levels in wells in the Early Winters area to rise 10 to 25 feet in a one- to two-week period (Golder Associates 1991). Conversely, during drought or low-flow years, certain reaches of tributary streams and rivers to the Methow and reaches of the Methow River itself can go dry under natural conditions (without diversions) (EMCON 1993). Winter anchor ice is another environmental baseline condition that occurs in the Methow River and certain other tributaries. This condition can force juvenile steelhead and spring chinook salmon to seek areas that remain ice-free to survive. Though the extent of damage from anchor ice on fish habitat is unknown, NOAA Fisheries assumes winter freezing conditions contribute to the degraded environmental baseline.

The relationship between groundwater and surface flow in the Methow Basin is complex. Surface flow in the Methow River can intermittently disappear and reappear in different reaches as it flows downstream. Groundwater can reverse its direction of flow as the water level drops in the Methow River, and it is uncertain into which aquifers and streams water goes when the irrigation diversions cease (Caldwell and Catterson 1992). Because of the hydrologic continuity of surface and groundwater in the basin, some believe that a large portion of the water diverted for agricultural or other domestic purposes returns near the point of diversion later in the year, improving conditions for riparian vegetation and fish. As a result, they assert that returning water is available for other uses (i.e., riparian vegetation watering, fish use, etc.) within the basin

(Mullan *et al*. 1992). NOAA Fisheries is unaware of any empirical support for this notion and generally believes that diverting flow from streams and rivers has contributed to degraded environmental baseline conditions for listed anadromous fish within stream segments that could be used by fish if conditions were suitable.

The conversion of floodplain areas to agricultural, residential, and commercial use has occurred throughout the Methow Valley. Past livestock grazing practices within riparian zones of the mainstem Methow River have negatively impacted these areas. The lingering effects of livestock grazing practices on private lands continue to have negative impacts in riparian areas. Agricultural practices and timber harvest have reduced riparian habitat in this sub-watershed. (BRT 2003).

The Methow still supports of number of pristine to nearly pristine habitats, mostly within designated wilderness areas. A number of important production areas, however, have been negatively affected by human activity. Irrigation water withdrawals have substantially reduced habitat quality and quantity during base flow periods in the mainstem Methow, lower Chewuck, and lower Twisp rivers. A number of lesser tributaries have been completely dried by irrigation withdrawals. Some of the diversions on the mainstem and large tributaries have been accomplished with gravel "push-up" dams that can impede passage during low flows and create locally unstable habitat conditions and maintaining these structures destroys redds. Most of the irrigation withdrawals have been screened to modern standards, but a few large diversions downstream of important production areas are inadequately screened. Several reaches of the mainstem and tributaries are listed under Section 303(d) of the Clean Water Act as impaired for various parameters, including temperature and instream flow. Most stream reaches downstream of wilderness areas lack sufficient instream flow. Large wood has historically been removed from stream channels following larger floods. Revetments have further limited channel complexity and off-channel habitat in the lower Lost, Chewuck, and Twisp rivers and at various locations on the mainstem. Riparian conditions have also been negatively affected as a result of agricultural, silvicultural, residential, and recreational activities.

The limiting factors have been: irrigation-related reductions to base flow, particularly in drier years; loss of off-channel habitats; lack of large wood; passage barriers or impediments at irrigation diversions; inadequate screening at some irrigation diversions; and loss of riparian vegetation. Sedimentation may also be a problem in the lower Chewuck. The nearly annual de-watering of small streams that support spring chinook spring rearing may also have been a significant limiting factor if the fish are unable to exit these systems before they dry up.

NOAA Fisheries reviewed the relevant records of completed consultations for this subbasin and found 14 formal and informal consultations completed for actions in the Methow subbasin (USGS HUC 17020008). These actions addressed water diversions, dam maintenance, boat ramp construction, flood control, fish passage, and habitat restoration. Implementation of these actions is expected to have direct or ancillary effects on instream flow, passage, and riparian conditions. The Corps was lead agency on three non-restoration actions including construction of a private pier, installation of a boat ramp in different subbasin tributaries, and construction of a new boat dock on the mainstem Columbia River. These were smaller projects that had short-term local effects and unquantifiable effects on the local population. The BPA completed consultation on a

project with the Yakama Nation to replace a culvert on Hancock Springs, which is a tributary to the Methow River. The purpose of this project is to restore salmonid access to the upper portion of Hancock Springs and improve riparian habitat and stream conditions. NOAA Fisheries concluded that this project was likely to improve population trend to the extent that the loss of passage had contributed to decline.

NOAA Fisheries consulted with other Federal agencies including batched watershed actions to address habitat and side channel restorations, dike removal and replacement of four culverts by the USFS, which are expected to provide small local benefits to habitat condition and improve fish passage. Other consultations included dam maintenance at the Leavenworth hatchery by the USFWS and culvert repair by the Federal Highway Administration, which is expected to provide a slight improvement in water quality, improved upstream passage of migrating adult spawners, and safer downstream migration of juveniles within the action area. This project will probably provide only incremental improvement to population status since an additional 35 or 40 culverts need replacement.

Based on this review, the consulted-upon Federal actions will have slight effects, generally beneficial, to factors limiting listed salmonids at the reach scale in the Methow subbasin..

5.4.3.3.2 Entiat (USGS HUC 17020010). Spring chinook spawning is presently limited to approximately 10 miles of the mainstem Entiat and the lower reaches of the Mad River. Spring chinook may have historically spawned lower in the mainstem, but the channelization of the lower 14 miles of the river has rendered conditions there unsuitable. This channelization, with associated loss of off-channel habitats and riparian function, is the most significant habitat alteration in the watershed. The Entiat has been less severely affected by water withdrawals, most of which have been downstream of the spawning areas, but water withdrawals have limited habitat quality and quantity, particularly in drier years. It is believed that all of the irrigation diversions in subbasin have been screened to modern standards. Sedimentation from forest lands has also been a significant factor. The steep terrain, highly erodible soils, forest road locations, and fire frequency have combined to make sedimentation a much more significant problem in the Entiat than in the other subbasins occupied by UCR spring chinook. The Entiat Valley has also grown in popularity as a retirement and vacation getaway. Some of the most desirable building locations have been along the floodplain reaches, where spring chinook continue to spawn. Most of the spring chinook production areas are stream reaches bordered by private land.

The primary limiting factors have resulted from channelization and levee construction, and they have included the loss of channel sinuosity and off-channel habitat, large woody debris and recruitment of same, habitat complexity, and channel length. Channelization has also significantly increased stream gradient in the lower 14 miles of the mainstem. Sedimentation and the effects of water withdrawals to late-season base flows have also been limiting factors.

Identified consultations in this subbasin included Forest Service improvements to the Silver Falls Access Area in the Entiat Ranger District, but these consultations do not affect the overall status of the environmental baseline in a measurable manner.

5.4.3.3.3 Wenatchee (USGS HUC 17020011). Important spawning areas in the White, Little Wenatchee, and Chiwawa rivers remain in healthy, properly functioning condition. Another important spawning area, Nason Creek, has been significantly affected by the highway and railroad construction, which severed a substantial amount of side channel habitat and truncated the floodplain. Highway and railroad construction and, to a lesser extent, residential development have also substantially reduced floodplain connectivity, side channel habitat, and riparian quality along much of the mainstem Wenatchee River. While the most important spawning areas are the previously listed tributaries, the mainstem Wenatchee is an important rearing and overwintering area. Irrigation impacts have been minor in the major tributaries, but irrigation withdrawals in lesser tributaries like Peshastin, Mission, and Chumstick creeks have precluded spring chinook in these systems for many years. The lower mainstem Wenatchee has been substantially affected by irrigation withdrawals in the late summer and early fall, particularly in drier years. The barrier at the Leavenworth National Fish Hatchery has blocked access to nearly 20 miles of suitable spring chinook habitat. Riparian conditions in the major tributaries, except in Nason Creek, are generally excellent. The mainstem Wenatchee downstream from Leavenworth is largely devoid of structural wood.

The primary limiting factors have been the loss of off-channel habitat in the mainstem and Nason Creek, which negatively affects late-summer rearing and overwintering conditions; late-season flows in the lower Wenatchee mainstem; and the lack of large, in-channel wood. Flow and passage problems in Mission and Peshastin creeks have prevented regular access. The barrier on the Icicle has prevented access to the upper river, but a recently formed fall several miles above the hatchery would likely prevent spring chinook access to most of the suitable habitat in that watershed.

NOAA Fisheries reviewed the relevant records of completed consultations for this subbasin and found two consultations completed for the Wenatchee subbasin. The Corps completed consultation on a project to install access to a swimming beach in the Lower White River. The Forest Service completed consultation on a road relocation and bank stabilization project on the White River and culvert replacements on Sand and Little Camas creeks. The White River project is expected to add temporary, construction-related effects to the existing environmental baseline. However, these effects are not expected to have any significance at the population level. The culvert replacements are expected to provide local improvements to fish passage.

Based on this review, the consulted-upon Federal actions will have slight effects, both adverse and beneficial, to factors limiting listed salmonids at the reach scale in the Wenatchee subbasin.

5.4.3.4 Harvest Rates

As indicated above, in order to estimate the extent of the baseline treaty harvest, NOAA Fisheries will presume that treaty and non-treaty harvest rates comparable to the current harvest rates will continue into the future pursuant to Court-approved settlement agreements. Mainstem harvest rates for UCR spring chinook salmon are set forth in the 2001 Interim Agreement on winter/ spring/summer fisheries (Table 5.4). There are no specific estimates of historical harvest impacts on UCR spring chinook runs. Assuming that these fish were equally available to mainstem commercial fisheries as were runs to other areas of the Snake and Columbia rivers,

harvest rates in the lower mainstem Columbia commercial fisheries were probably on the order of 20 to 40% of the in-river run. Harvest rates were sharply curtailed beginning in 1980 and were again reduced after the listing of Snake River spring/summer chinook in the early 1990s. Only mainstem Columbia River fisheries harvest Upper Columbia River spring chinook in significant numbers. Mainstem harvest rates depend on run size and can vary from 5.5 to 17% (including Tribal and non-Tribal harvest).

5.4.3.5 Artificial Propagation Programs

Future artificial propagation operations as described in Section 5.3.5 are part of the environmental baseline.

5.4.4 Upper Willamette Chinook Salmon

5.4.4.1 Mainstem

Juvenile UWR chinook salmon migrate through the mainstem lower Columbia River primarily as yearlings, although subyearlings migrants from this ESU are also moderately common (Fresh *et al.* 2004). Juvenile UWR chinook salmon enter the action area at the mouth of the Willamette River, at approximately RM 100 in the lower Columbia River. Most of the migration moves through the lower Columbia River during February through May, before peak spring runoff and periods of involuntary spill. The primary factors affecting the status of this ESU as juveniles move through the estuary and plume have varied with life history strategy. Avian predation and flow are limiting factors for yearlings (Section 5.3.1). Fingerling smolts have a relatively long residence time in the estuary and rely extensively on shallow water habitats to provide both food for high growth rates and shelter from predators (Fresh *et al.* 2004). Thus, the primary estuarine limiting factors for subyearlings have been flow and the associated reduction in amount of and access to shallow water habitat.

5.4.4.2 Tributary Habitat Conditions

The action area for Upper Willamette chinook includes all tributary subbasins to which adult fish return and therefore are potentially affected by a reduction of marine-derived nutrients. The Action Agencies have not proposed offsetting measures for effects of the hydrosystem on tributary habitat used by this ESU. Conditions under the environmental baseline in those subbasins occupied by this ESU are described in Appendix E and incorporated here by reference.

5.4.4.3 Harvest Rates

As indicated above, in order to estimate the extent of the baseline treaty harvest, NOAA Fisheries will presume that treaty and non-treaty harvest rates comparable to the current harvest rates will continue into the future pursuant to Court-approved settlement agreements. Mainstem harvest rates for UWR chinook salmon are set forth in the 2001 Interim Agreement on winter/spring/summer fisheries (Table 5.3).

5.4.4.4 Artificial Propagation Programs

Future artificial propagation operations as described in Section 5.3.5 are part of the environmental baseline.

5.4.5 Lower Columbia River Chinook Salmon

5.4.5.1 Mainstem

Most LCR chinook salmon populations are fall-run and produce primarily subyearling migrants. Subyearlings move through the mainstem lower Columbia River during spring and early summer. Only subyearlings that emerge from the Wind, Little White Salmon, and [Big] White Salmon rivers in Washington and the Hood River in Oregon would encounter Bonneville Dam after entering the Columbia River. NOAA Fisheries does not know of any empirical information on the survival of small subyearling migrants at Bonneville Dam. Experiments conducted with juvenile SR fall chinook do not apply, because these fish are much larger by the time they reach Bonneville Dam (Section 5.4.2).

Table 5.1 estimates juvenile in-river survival rates for LCR chinook salmon in the reference operation under 1995-2003 water-year conditions ranging from 87% to 94% (mean over 91%) for yearling LCR chinook salmon and almost 80% to over 97% (mean over 88%) for subyearling LCR chinook.

As described in Section 5.2.2.3.1.2, these estimates are lower than the estimated survival through free-flowing river reaches (see Table 5.1). The updated estimate of the mean free-flowing survival from 1995-2003 data for yearling LCR chinook is 98.4% and for subyearling LCR chinook, 95.5% (Ferguson 2004). Because survival through free-flowing river sections is assumed to approximate the survival rate associated with properly functioning habitat conditions (see Section 1.2.2.2), the lower survival rates associated with the reference operation indicate that the biological requirements of juveniles have not been fully met within the range of recent runoff conditions and would not be fully met under the reference operation.

Small subyearling migrants are likely to have biological requirements for food in the mainstem Columbia River migration corridor, but NOAA Fisheries is uncertain whether the abundance or composition of the prey assemblage is enhanced or adversely affected by hydro operations. Smolts from this ESU are generally small (fry and fingerlings), which have long residence times in the estuary and rely extensively on shallow-water habitats to provide both food for high growth rates and shelter from predators (Section 5.3.4). The primary estuarine limiting factors have been flow and the associated reduction in amount of and access to shallow water habitat.

Three spring-run populations (Hood, Kalama, and Sandy rivers) produce yearling migrants, and juveniles emerging from the Hood River pass Bonneville Dam on their way downstream. NOAA Fisheries assumes that the survival of yearling smolts emerging from the Hood River and the biological requirements of smolts from all three populations are similar to those of yearling SR spring/summer chinook salmon in the same portion of the action area.

Biological requirements of adults for water quality, quantity, and velocity in the mainstem Columbia River migration corridor are different for the spring- and fall-run components of this ESU. For spring-run chinook salmon, effects are similar to those described above for SR spring/summer chinook salmon (Section 5.4.1). For fall-run fish returning to Upper Gorge spawning areas, low flows during late summer and early fall, related to high temperatures, may delay migration through the Bonneville pool and potentially lead to disease transmission between adults delayed in fish ladders.

Past hydropower operations have affected the quantity and quality of, and access to, spawning habitat in the Ives Island area below Bonneville Dam, where several early fall-run chinook salmon from the LCR ESU were observed spawning during October 1999. The reference operation includes spill operations at Bonneville Dam, such as spill for debris removal, gas generation/abatement testing, or juvenile fish passage, which could create TDG concentrations high enough to kill yolk sac fry in redds in the Ives Island area. However, this effect is prevented in the reference operation by providing flows that create a compensation depth over the redds and/or by reducing the effective TDG concentration to 105% of saturation or less. Flow fluctuations can strand subyearling migrants, making them vulnerable to desiccation or avian predation. In the reference operation, both flow and spill operations at Bonneville Dam are assumed to be managed to protect chum salmon, as has occurred since 1999. Beginning approximately November 1, the Action Agencies have since 1999 provided some operations to maintain minimum tailwater elevations at Bonneville to establish and protect redds, although the extent of these operations has depended on the hydrologic forecasts and the ability to implement other seasonal operations. Efforts have also been made to limit spill to a level which would not exceed 105% over established redds. These efforts to protect chum salmon, which are assumed to continue in the reference operation, would also confer protection on established LCR chinook redds and emergent fry

Average adult survival past Bonneville Dam estimated in Table 5.2 from recent (1996-1998 and 2000-2002) adult survival radio-tracking study data, based on SR spring/summer and SR fall chinook per project survival rates, ranges from 98.0-97.4% (Appendix D, Attachment 4). As described in Section 5.2.2.3.4, this survival rate appears similar to that which would be expected under free-flowing river conditions. Therefore, it is likely that the biological requirements associated with adult migration have been met in recent years and would also be met under the reference operation.

5.4.5.2 Estuary and Plume Habitat Conditions

Most juvenile emigrants from this ESU are ocean-type fish, which migrate to sea early in their first year of life after rearing in freshwater for only a short period. These smaller juveniles rear in shallow, low velocity estuarine habitat, which has diminished due to flow changes and diking. The primary factors affecting the status of ocean-type juveniles as they move through the lower Columbia River have been habitat, flow and toxics. For the three populations that produce yearling-type smolts, the status of habitat in the estuary and plume is the same as that described for SR spring/summer chinook salmon (Section 5.4.1.2).

5.4.5.3 Tributary Habitat Conditions

The action area for Lower Columbia River chinook includes all tributary subbasins to which adult fish return and therefore are potentially affected by a reduction of marine-derived nutrients. The Action Agencies have not proposed offsetting measures for effects of the hydrosystem on tributary habitat used by this ESU. Conditions under the environmental baseline in those subbasins occupied by this ESU are described in Appendix E and incorporated here by reference.

5.4.5.4 Harvest Rates

As indicated above, in order to estimate the extent of the baseline treaty harvest, NOAA Fisheries will presume that treaty and non-treaty harvest rates comparable to the current harvest rates will continue into the future pursuant to Court-approved settlement agreements. Mainstem harvest rates for LCR chinook salmon are set forth in the 2004 Fall Agreement and the 2001 Interim Agreement on winter/spring/summer fisheries for the fall and spring-run components, respectively (Tables 5.3 and 5.4 and Appendix C). For fall chinook, total exploitation rates were as high as 80% before 2001. Since 2001, the harvest cap is 49%. For spring chinook, total exploitation rates were as high as 65% prior to 2001. Since then, exploitation rates have been reduced to 22%.

5.4.5.5 Artificial Propagation Programs

Future artificial propagation operations as described in Section 5.3.5 are part of the environmental baseline.

5.4.6 Snake River Steelhead

5.4.6.1 Mainstem

Juvenile SR steelhead migrate as yearlings, with peak movement past Lower Granite Dam during April and May. Using the SIMPAS model, NOAA Fisheries has estimated that an average of about 74% of the run starting at the head of Lower Granite pool was transported from the Snake River collector projects under 1994 through 2003 runoff conditions in the reference operation (Appendix D). The direct survival of transported juveniles over the same period was at least 98%, and the average system survival rate shown in Table 5.1 of in-river migrants (which migrate past eight mainstem projects) ranged from 6% up to 47%, with a mean survival of approximately 34%. These survival estimates do not include possible effects of latent mortality for in-river migrants. From Table 5.1, the total (transported plus in-river) system survival rate for SR steelhead in the reference operation ranged from nearly 43% to almost 54%, with a mean value of almost 50%, including differential delayed mortality of transported fish assumed in the analysis. The status of habitat that provides biological requirements in the juvenile migration corridor (e.g., water quality, food) is very similar to that described for SR spring/summer chinook (Section 5.4.1.1.1).

As described in Section 5.2.2.3.1.2, these estimates are lower than the estimated survival through free-flowing river sections (see Table 5.1). The updated estimate of the mean free-flowing

survival from 1995-2003 data is 82.1% (Ferguson 2004). This indicates that a significant portion of the mortality of SR steelhead can be attributed to the existence and operation of FCRPS dams and reservoirs. Because free-flowing river survival rates are assumed to approximate the survival rate associated with properly functioning habitat conditions (Section 1.2.2.2), the lower survival rates attributed to the reference operation indicate that biological requirements of juveniles have not been fully met in recent water conditions and would not be fully met under the reference operation.

Based on radio-tracking studies of SR steelhead in 1996-97 and 2001-02, the minimum mean survival rate of adult migrants between Bonneville and Lower Granite dams shown in Table 5.2 is 83.3%, equivalent to a per-project survival rate of 97.7% (Appendix D, Attachment 4). As described in Section 5.2.2.3.4, this survival rate appears similar to that which would be expected under free-flowing river conditions. Therefore, it is likely that the biological requirements associated with adult migration have been met in recent years and would also be met under the reference operation.

Few downstream-migrating adult steelhead (kelts) survive to spawn a second time without passing through dams (7% to lower Columbia River tributaries). However, recent studies have shown an increasing percentage of kelts (34.4% in 2003) surviving to below Bonneville Dam with provision of flows, spills, and sluiceway operation (Boggs and Peery 2004).

5.4.6.2 Estuary and Plume Habitat Conditions

The status of the habitat in the estuary and plume for this yearling-type ESU is the same as that described for SR spring/summer chinook salmon (Section 5.4.1.2).

5.4.6.3 Tributary Habitat Conditions

The action area for Snake River steelhead includes all tributary subbasins to which adult fish return and therefore are potentially affected by a reduction of marine-derived nutrients. In three subbasins the Action Agencies propose conservation measures as part of their Updated Proposed Action. Conditions in the tributary subbasins where conservation actions will occur are described in the following subsections. These three subbasins are generally representative of conditions in the remaining subbasins with similar habitat and land use. Appendix E, the Limiting Factors Analysis, prepared to guide the development of the UPA further informs this evaluation of the environmental baseline in the tributary habitat. The subbasins occupied by this ESU in addition to those discussed below are evaluated in Appendix E. For the purposes of this biological opinion, the effects of these representative subbasins, described below, are extrapolated to all subbasins.

5.4.6.3.1 Little Salmon and Rapid River (USGS HUC 17060210). The Little Salmon River, approximately 43 miles long, enters the main Salmon at RM 82. The Little Salmon River subbasin includes a total of 372,500 acres, and the Payette National Forest manages approximately 11% (40,975 acres) of the area. The USFS lands (Payette and Nez Perce National forests) make up the majority of the subbasin, followed by private, BLM, and state lands. The upper half of the watershed is in a wide valley surrounded by forested mountain slopes. The

valley is characterized as pasture and meadowlands, with the Little Salmon River meandering through the valley.

A large variety of past and present land uses have impacted listed species habitat to varying levels. Human activities in the subbasin include logging, roads, trails, water withdrawal, agriculture, livestock grazing, residences, communities, and recreation. The higher-elevation lands administered by the USFS have been used for timber harvest, livestock grazing, and recreation. The BLM lands within the subbasin have also been used in a manner similar to USFS lands, which is primarily for timber harvest and livestock grazing. Major subwatersheds in the Little Salmon River include Rapid River, Elk Creek, Boulder Creek, Hazard Creek, Hard Creek, Round Valley Creek, and Goose Creek. U.S. Highway 95 parallels the Little Salmon River and encroaches on riparian areas and floodplains in the lower canyon reach. Several small towns are in the subbasin, ranging in size from a few hundred people to slightly more than one thousand. The predominant uses on Payette National Forest lands include roads and timber harvest (BRT 2003).

The watersheds within this subbasin have been degraded from their historical conditions and are believed to be limiting for spring/summer chinook because of flow, altered channel morphology, temperature, and the lingering effects of grazing, roads, and forestry practices. The lack of a properly functioning riparian corridor in the Little Salmon River has affected stream temperatures and the structure of the channel due to a lack of LWD recruitment. (NWPPC 2004b) Water has been diverted for numerous purposes, homes have been built near the high-water mark, and most tributaries are inaccessible. State Highway 55 constricts channel migration.

The anticipated effects of completed Section 7 consultations in this subbasin are described in Section 5.4.1.3.1.

5.4.6.3.2 Lemhi River (USGS HUC 17060204). The Lemhi River watershed drains approximately 1,260 square miles between the Beaverhead Range on the north and east sides and the Lemhi Range on the west. Elevations range from 4,100 feet above mean sea level (amsl) at the confluence with the Salmon River one mile north of the town of Salmon to over 11,000 feet amsl. Average annual precipitation ranges from 7 inches at lower elevations to 23 inches in the mountains. Most of the land immediately adjacent to the Lemhi River and its major tributaries is in private ownership. The Bureau of Land Management (BLM) manages the land at the mid-elevations, and the US Forest Service (USFS) manages the high-elevation forests. State-owned lands are scattered throughout the basin (USDI-BLM 1999).

The Lemhi River is a low-gradient, spring-fed system. The hydrology has been changed dramatically in the last 150 years, beginning with beaver and beaver dam removal and more recently with extensive irrigation withdrawals and channel alterations. All tributaries except Hayden Creek and Big Springs Creek are seasonally dewatered and no longer reach the mainstem Lemhi during the irrigation season (April to October) (USDI-BLM 1999).

The watersheds within this subbasin have been degraded from their historical conditions and are believed to be limiting for spring/summer chinook because of flow, altered channel morphology,

temperature, water quality, and the lingering effects of grazing and agricultural practices which cause an increase in sedimentation. The hydrologic regime (peak flows, base flows, flow timing) and connectivity of most Lemhi tributaries have been altered by irrigation withdrawals. Only 7% of all tributaries remain connected to the mainstem. These changes limit the access of resident and anadromous populations to potentially available habitat and delay anadromous smolt and adult migration in the lower reaches of the mainstem Lemhi, which contributes to increased mortality rates (NWPPC 2004b).

Currently, fish passage through the lower portion of the river has been impaired by low water conditions and structures associated with irrigation diversions. In 2001, the Idaho Office of Species Conservation, Idaho Department of Water Resources, Idaho Department of Fish and Game, NOAA Fisheries, USFWS, the Lemhi Irrigation District, Water District 74, and the Upper Salmon Basin Watershed Project entered into an agreement (Lemhi Agreement) that, among other things, provides stream flows sufficient for fish passage between the L6 diversion and the mouth of the Lemhi River. This is done through a combination of landowner agreements and annual water leases that are still being refined. In addition to the Lemhi Agreement, the USBR is pursuing several diversion improvements to comply with the 2000 FCRPS Biological Opinion (NMFS 2000a). Together, these activities should improve passage in the lower river, which has adversely impacted upstream and downstream migrants. In addition, the Upper Salmon River Watershed Project is actively working with landowners to improve riparian habitat on private land. A comprehensive listing of past and current restoration efforts in the Lemhi can be found in the 2002 Lemhi Agreement (IOSC *et al.* 2002; NOAA Fisheries 2002)

The anticipated effects of Section 7 consultations completed in this subbasin are described in Section 5.4.1.3.2.

5.4.6.3.3 Salmon River Upper Mainstem (above the confluence with the Pahsimeroi River) (USGS HUC 17060201). Most of the Upper Salmon River is a transport system. The Stanley basin and Round Valley are the most important response reaches because of their large floodplains. The river has been crowded to one side of Round Valley, probably to add space for ranching and irrigated agriculture in the early 20th century. Residents upstream of and within the area have constructed numerous flood-prevention structures (i.e., dikes, gravel removal from the channel bed, etc.) to protect their property. Based on site observations and air photo interpretation, the Corps believes that the alignment of the channel has been grossly altered by these activities (Higginbotham 2003). The change in alignment, loss of stabilizing riparian vegetation, and sediment load from upstream have caused instability in the channel, with roughly 70% of the banks showing evidence of active erosion. The channel now lacks the distribution of riffle and pool habitat (roughly 50% of each) that is preferred for salmonid rearing. The existing Upper Salmon River is largely run (glide) habitat, with a small amount of riffle habitat. There are only 5 to 10 square meters of high quality pool habitat in the project area. The geomorphic changes and intensity of irrigation withdrawals have resulted in some river segments having inadequate surface flows during the irrigation season. The channel lacks large woody debris that is correlated with the low level of existing riparian vegetation. Large wood may have been removed by landowners to prevent possible flooding of their property or by rafting guides to eliminate safety hazards, and it is moved naturally during high water events. There is little instream diversity and instream cover (less than 5%).

Upper Salmon River water quality is relatively high. Some streams have sediment and high concentrations of nutrients and metals, particularly in watersheds where improper road construction, mining, and livestock grazing have occurred (USRITAT 1998). The Salmon River corridor was included in the IDEQ 303(d) water quality-impaired list in 1998 because of polluted sediments and high temperatures from Redfish Lake Creek downstream to the East Fork Salmon River. Major streams that flow into the Salmon River within the USRC area include Morgan Creek, Challis Creek, and Garden Creek from the west and Pennal Gulch from the east (BRT 2003).

The watersheds within this subbasin have been degraded from their historical conditions and are believed to be limiting for spring/summer chinook because of flow, altered channel morphology, and the lingering effects of past grazing activities. The natural hydrologic regime in the Upper Mainstem Salmon (from the East Fork confluence to the headwaters) has been altered by streamflow withdrawals. The effects from these pressures include a reduction in base flow conditions and some modifications in flow timing (NWPPC 2004b). Sedimentation from various land use activities has impacted habitat quality and quantity in the mainstem from the East Fork confluence to the headwaters (NWPPC 2004b). Roads, timber harvest, grazing, and changes to the hydrologic regime of the small Upper Salmon tributaries have acted alone or cumulatively to contribute excess amounts of fine sediment to channels (NWPPC 2004b).

The anticipated effects of Section 7 consultations completed in this subbasin are described in Section 5.4.1.3.3.

5.4.6.3.4 Clearwater (HUC 17060306). The Clearwater River subbasin includes the mainstem Clearwater River and tributaries accessible to anadromous fish below the South Fork Clearwater River confluence. This subbasin includes a total of 1,497,000 acres. BLM lands within the subbasin total 21,340 acres (one percent). USFS lands total 136,000 acres (nine percent). The majority of the ownership in the subbasin is private. Other ownership in the drainage includes Idaho Dept. of Lands, Nez Perce Tribe, Corps of Engineers, and Idaho Fish and Game. The Clearwater River flows into the Snake River at Lewiston, Idaho, and Clarkston, Washington.

Elevations within the subbasin range from 700 feet at the mouth of the Clearwater River to 5,810 feet in the headwaters of Lolo Creek. The Clearwater River flows through a canyon that is 2,000 to 3,000 feet deep. The adjacent plateaus or uplands are rolling and moderately sloped, and are primarily agricultural areas. Higher elevation areas in the subbasin are forested. Private land uses include agriculture, timber harvest, livestock grazing, recreation, roads, urban development, and residences. Potlatch Corporation, a private timber company, has significant land ownership in the upper Potlatch and Lolo Creek watersheds. Scattered Nez Perce Tribal lands also occur throughout the subbasin. The USFS lands are limited to blocks in the upper Potlatch, Lolo, and Orofino Creek watersheds. The BLM lands within the subbasin are scattered and generally comprise only a small percentage of any watershed. Land uses on BLM lands primarily include timber harvest, livestock grazing, roads, and recreation. Many streams in this subbasin no longer support anadromous fish, and have been severely altered by roads, farming, housing development, streamside grazing, and small water withdrawals.

The Nez Perce Tribe has been active in recent introductions of fall chinook salmon and coho salmon within the subbasin. The mainstem Clearwater River is used as an upstream and downstream passage corridor by fall chinook salmon, steelhead, spring/summer chinook salmon, and coho salmon. Fall chinook salmon use the mainstem Clearwater River for spawning and rearing. Steelhead are dispersed throughout this hydrologic unit, and use most accessible tributaries for spawning and rearing. Elevated water temperature, sediment deposition and low streamflows in the summer and fall limit salmon and steelhead use of many streams in this subbasin. Spring/summer chinook salmon and steelhead use the mainstem river, to a very limited extent, for spawning and rearing.

5.4.6.4 Harvest Rates

As indicated above, in order to estimate the extent of the baseline treaty harvest, NOAA Fisheries will presume that treaty and non-treaty harvest rates comparable to the current harvest rates will continue into the future pursuant to Court-approved settlement agreements. Mainstem harvest rates for SR steelhead salmon are set forth in the 2001 Interim Agreement on winter/spring/summer fisheries (Table 5.3).

5.4.6.5 Artificial Propagation Programs

Future artificial propagation operations as described in Section 5.3.5 are part of the environmental baseline.

5.4.7 Upper Columbia River Steelhead

5.4.7.1 Mainstem

5.4.7.1.1 FCRPS Projects. Juvenile UCR steelhead are yearling migrants, moving through the mainstem Columbia River during spring. The status of biological requirements for this ESU related to mainstem habitat and in the estuary and plume, and potential interactions with out-of-ESU hatchery fish, are the same as those discussed for SR spring/summer chinook salmon (Section 5.4.1). The status of biological requirements for water quality, quantity, and velocity in adult migration corridors is also the same as those discussed for SR spring/summer chinook salmon (Section 5.4.1).

Appendix D estimates that juvenile in-river survival through the lower Columbia River reach in the reference operation ranges from less than 21% to 67% during the 1994-2003 study period, with a mean of 51.4%. These estimates indicate that the habitat-related biological requirements of juveniles, as described in Section 5.4.1.2, are not being fully met. This estimate does not include the effect of latent mortality for in-river migrants.

These estimates are lower than estimated survival through free-flowing river sections, which is assumed to approximate the survival rate associated with properly functioning habitat conditions. The updated estimate in Table 5.1 of the mean free-flowing survival using 1995-2003 data is 87.9% (Smith 2003).

Average adult survival estimated in Table 5.2 based on recent (2001-2002) radio tracking studies is estimated at 94.1%, with a per project survival rate of over 98.5% (Appendix D).

5.4.7.1.2 Habitat Conservation Plans for FERC-licensed Projects in the Mid-Columbia Reach. The permitted levels of take for juvenile and adult UCR steelhead under the HCPs is described in Section 5.4.3.1.2. Project-related mortality of downstream migrating UCR steelhead kelts is generally unknown, although survival of kelts from all tributaries within the action area to below Priest Rapids Dam was estimated at about 18% in 2002. There are no estimates of "natural" mortality rates for these fish, which have gone many months without feeding while expending considerable energy migrating and spawning, but these are thought to be high. NOAA Fisheries expects that, compared to pre-HCP survival rates, implementing HCP measures at the mid-Columbia PUD projects will substantially improve steelhead kelt survival in future years.

5.4.7.2 Estuary and Plume Habitat Conditions

The status of the habitat in the estuary and plume for this yearling-type ESU is the same as that described for SR spring/summer chinook salmon (Section 5.4.1.2).

5.4.7.3 Tributary Habitat Conditions

The action area for UCR River steelhead includes all tributary subbasins to which adult fish return and therefore are potentially affected by a reduction of marine-derived nutrients. In four subbasins the Action agencies propose conservation actions and measures as part of their Updated Proposed Action. Conditions in the tributary subbasins where conservation actions will occur are described in the following subsections. These four subbasins are generally representative of conditions in the remaining subbasins with similar habitat and land use. Appendix E, the Limiting Factors Analysis, prepared to guide the development of the UPA, further informs this evaluation of the environmental baseline in the tributary habitat. The subbasins occupied by this ESU in addition to those discussed below are evaluated in Appendix E. For the purposes of this biological opinion, the effects of these representative subbasins, described below, are extrapolated to all subbasins.

5.4.7.3.1 Methow (USGS HUC 17020008). The Methow subbasin still supports of number of pristine to nearly pristine habitats, mostly within designated wilderness areas. A number of important production areas, however, have been and continue to be negatively affected by human activity. Irrigation water withdrawals have substantially reduced habitat quality and quantity during base flow periods in the mainstem Methow, lower Chewuck, and lower Twisp rivers (Appendix E). Irrigation diversions have reduced habitat quality and quantity and impeded adult steelhead passage in Gold, Libby, and Beaver creeks. A number of lesser tributaries have been completely dried by irrigation withdrawals. Those that do not support steelhead spawning are occupied by juvenile steelhead in the late spring and winter. Some of the diversions on the mainstem and large tributaries have been accomplished with gravel “push-up” dams that can impede passage during low flows and create locally unstable habitat conditions. Furthermore, maintaining these structures can destroy redds. Most of the irrigation withdrawals are screened to modern standards, but a few large diversions downstream of important production areas are

inadequately screened. Several reaches of the mainstem and tributaries are listed under Section 303(d) of the Clean Water Act as impaired for various parameters, including temperature and instream flow. Most stream reaches downstream of wilderness areas lack sufficient instream flow. Large wood has historically been removed from stream channels following larger floods. Revetments have further limited channel complexity and off-channel habitat in the lower Lost, Chewuck, and Twisp rivers and at various locations on the mainstem. Riparian conditions have also been adversely affected as a result of agricultural, silvicultural, residential, and recreational activities.

The current limiting factors have resulted from irrigation-related substantial reductions to base flow, particularly in drier years; loss of off-channel habitats; lack of large wood; passage barriers or impediments at irrigation diversions; inadequate screening at some irrigation diversions; and loss of riparian vegetation. Sedimentation may also be a problem in the lower Chewuck. The nearly annual dewatering of small streams that support rearing may also be a significant limiting factor if these fish are unable to exit these systems before they dry up.

The anticipated effects of Section 7 consultations completed in this subbasin are described in Section 5.4.3.3.1.

5.4.7.3.2 Entiat (USGS HUC 17020010). Steelhead spawning presently occurs in portions of the mainstem Entiat, the Mad River, and Roaring Creek. The channelization of the lower 14 miles of the river has reduced steelhead spawning habitat suitability in that reach. This channelization and associated loss of off-channel habitats and riparian function are the most significant habitat alterations in the watershed. The Entiat has been less severely affected by water withdrawals, most of which have been downstream of the spawning areas, but water withdrawals have limited habitat quality and quantity, particularly in drier years. It is believed that all of the irrigation diversions in the subbasin have been screened to modern standards. Sedimentation from forest lands has also been a significant factor. The steep terrain, highly erodible soils, forest road locations, and fire frequency have combined to make sedimentation a much more significant problem in the Entiat than in the other subbasins occupied by UCR steelhead. The Entiat Valley has also been growing in popularity as a retirement and vacation destination. Some of the most desirable building locations have been along the productive floodplain reaches.

The current primary limiting factors have resulted from channelization and levee construction and include the loss of: channel sinuosity and off-channel habitat; large woody debris and recruitment of same; habitat complexity; and channel length. Channelization has also significantly increased stream gradient in the lower 14 miles of the mainstem. As mentioned previously, sedimentation and the past effects of water withdrawals on late-season base flows have also been identified as limiting factors.

The anticipated effects of Section 7 consultations completed in this subbasin are described in Section 5.4.3.3.2.

5.4.7.3.3 Wenatchee (USGS HUC 17020011). Important spawning areas in the White, Little Wenatchee, and Chiwawa rivers and Chewaukum Creek remain in healthy, properly functioning condition. Another important spawning area, Nason Creek, has been significantly affected by the

highway and railroad construction that severed a substantial amount of side channel habitat and truncated the floodplain (Appendix E). Other significant but lesser tributaries, Peshastin, Chumstick, and Mission creeks, have been substantially altered by road construction, residential development, and water withdrawals. Highway and railroad construction and, to a lesser extent, residential development have also substantially reduced floodplain connectivity, side channel habitat, and riparian quality along much of the mainstem Wenatchee River. While the most important spawning areas are the previously listed tributaries, the mainstem Wenatchee is an important rearing and overwintering area. The lower mainstem Wenatchee has been substantially affected by irrigation withdrawals in the late summer and early fall, particularly in drier years. The barrier at the Leavenworth National Fish Hatchery has blocked access to nearly 20 miles of highly productive steelhead habitat. Riparian conditions in the major tributaries, except in Nason Creek, are generally excellent. The mainstem Wenatchee downstream from Leavenworth is largely devoid of structural wood.

The primary limiting factors have been the loss of access to the upper Icicle River, loss of off-channel habitat in the mainstem and Nason Creek, all of which have negatively affected late-summer rearing and overwintering conditions and the habitat in other significant tributaries like Peshastin, Mission, and Chumstick Creeks. Late-season flows in the lower Wenatchee mainstem and the lack of large, in-channel wood have also been significant problems.

The anticipated effects of completed Section 7 consultations in this subbasin are described in Section 5.4.3.3.3.

5.4.7.3.4 Okanogan. (USGS HUC 17020006). The construction of numerous dams in British Columbia and on Salmon Creek in the U.S. in the early 1900s blocked access to many miles of historically productive habitat in the Okanogan. Much of the habitat in the Okanogan system is in poor condition. The mainstem is too warm during the late spring and summer to support steelhead rearing, except near areas of isolated upwelling. The temperature problem in the mainstem is partially rooted in natural conditions but has been substantially exacerbated by the many top-discharge impoundments in the system and by the withdrawal of several hundred cubic feet per second (cfs) for irrigated agriculture on both side of the border. Water quality in the mainstem has also been compromised by very high sedimentation rates resulting from bank erosion and poor land management practices. Irrigation water withdrawals have dewatered most tributaries before they join the mainstem. Farming and grazing activities have further reduced habitat quality. The mainstem also supports robust populations of smallmouth bass and northern pikeminnow, so predation rates are likely high. Under present conditions, viable steelhead habitat is limited to a few patches in the mainstem Okanogan and lower Similkameen rivers, Omak Creek, and a few lesser tributaries. The potential benefits of restoring or providing passage into suitable habitat is high, if not in absolute productivity gains, then in relative gains for this small population.

The anthropogenic limiting factors are warm water resulting from lingering effects of impoundment and water withdrawal, access barriers to suitable habitats, tributary dewatering, and high sedimentation rates.

NOAA Fisheries reviewed the relevant records of completed consultations for this subbasin and found two formal consultations completed for actions in the Okanogan subbasin (USGS HUC 17020006). These actions addressed bank stabilization and bridge replacement. The Natural Resource Conservation Service (NRCS) completed two bank stabilization actions on private property along Salmon Creek. The Federal Highway Administration (FHWA) completed consultation to replace an existing bridge on Omak Creek. In the aggregate these Federal actions will potentially have small, local, short-term effects which are not expected to be significant at the ESU scale for UCR steelhead.

5.4.7.4 Harvest Rates

As indicated above, in order to estimate the extent of the baseline treaty harvest, NOAA Fisheries will presume that treaty and non-treaty harvest rates comparable to the current harvest rates will continue into the future pursuant to Court-approved settlement agreements. Mainstem harvest rates for UCR steelhead salmon are set forth in the 2001 Interim Agreement on winter/spring/summer fisheries (Table 5.3).

5.4.7.5 Artificial Propagation Programs

Future artificial propagation operations as described in Section 5.3.5 are part of the environmental baseline.

5.4.8 Mid-Columbia River Steelhead

5.4.8.1 Mainstem

Juvenile MCR steelhead are yearling migrants, moving through the mainstem lower Columbia River during spring. Depending on natal tributary, smolts from this ESU pass one to four FCRPS and USBR projects in the lower Columbia River. The status of biological requirements for this ESU related to mainstem habitat and in the estuary and plume, and potential interactions with out-of-ESU hatchery fish, are discussed for SR spring/summer chinook salmon (Section 5.4.1). The status of biological requirements for water quality, quantity, and velocity in adult migration corridors is also the same as those discussed for SR spring/summer chinook salmon (Section 5.4.1).

Appendix D derived the estimated in-river survival in the reference operation for each case, as shown in Table 5.1. These estimates indicate that the habitat-related biological requirements of juveniles, as described in Section 5.4.1.2, are not being fully met.

Table 5.5 . Estimates of in-river survival for juvenile MCR steelhead, derived from Appendix D.

Major Pop. Group – Pop. (No. FCRPS Projects)	Range (percent)	Mean (percent)
Yakima River – Satus and Toppenish creeks, Naches River, and Upper Yakima River (4 FCRPS projects)	21-67	51
Walla Walla and Umatilla rivers – Touchet River and Walla Walla River (4 FCRPS projects)	21-67	51
Rock Creek (3 FCRPS projects)	32-77	60
Walla Walla and Umatilla rivers – Umatilla River (3 FCRPS projects including John Day pool)	32-77	60
John Day River – Upper Mainstem John Day River, South Fork John Day River, Middle Fork John Day River, North Fork John Day River, and Lower Mainstem John Day River (3 FCRPS projects)	44-90	73
Cascade Eastern Slope – Deschutes River Westside Tributaries and Deschutes River Eastside Tributaries (2 FCRPS projects)	45-93	75
Cascade Eastern Slope – Fifteen Mile Creek and Klickitat River (1 FCRPS project)	65-97	86

These estimates are lower than estimated survival rates through free-flowing river sections, which is assumed to approximate the survival rate associated with properly functioning habitat conditions. The updated estimate of the mean free-flowing survival from 1995-2003 is 89.5% (Smith 2003).

Ferguson (2004) estimated the free-flowing survival to range from approximately 89-99%, depending upon the number of dams each population passes (Table 5.1).

Average adult survival estimated in Table 5.2 ranged from 93-97%, depending upon the number of dams a population passes, with a per project survival rate based on the adult SR steelhead rate of 97.7% (Appendix D).

5.4.8.2 Estuary and Plume Habitat Conditions

The status of the habitat in the estuary and plume for this yearling-type ESU is the same as that described for SR spring/summer chinook salmon (Section 5.4.1.2).

5.4.8.3 Tributary Habitat Conditions

The action area for Mid Columbia River steelhead includes all tributary subbasins to which adult fish return and therefore are potentially affected by a reduction of marine-derived nutrients. In three subbasins the Action agencies propose conservation actions and measures as part of their Updated Proposed Action. Conditions in the tributary subbasins where conservation actions will occur are described in the following subsections. These three subbasins are generally representative of conditions in the remaining subbasins with similar habitat and land use. Appendix E, the Limiting Factors Analysis, prepared to guide the development of the UPA, further informs this evaluation of the environmental baseline in the tributary habitat. The

subbasins occupied by this ESU in addition to those discussed below are evaluated in Appendix E. For the purposes of this biological opinion, the effects of these representative subbasins, described below, are extrapolated to all subbasins.

5.4.8.3.1 North Fork John Day River (NFJD) (USGS HUC 17070202). The John Day River system is un-dammed and contains runs of relatively genetically pure anadromous fish, including MCR steelhead. Fish populations have declined significantly over the past 100 years, but the NFJD subbasin sustains one of the few remaining wild anadromous fish runs in the mid-Columbia River basin and is the most important subbasin in the John Day basin in terms of water quality and flow contribution. Much of the NFJDR subbasin is located within the Umatilla National Forest (UNF), and the continuing health of this system is dependent on the health of upland forest communities. Factors such as percent forest canopy, soil type, slope, elevation, and land use practices have influenced the amount and quality of water entering the subbasin. Natural disturbances are common in this area and include floods, fires, avalanches, and insect epidemics. Human-caused physical disturbances have also been widespread and included extensive mining, timber harvest, grazing, and water diversions. Streams in the upper NFJD system generally have good channel structure and riparian and instream cover, as well as good water quantity and quality. This area provides approximately 700 miles of steelhead habitat. However, steelhead production in the subbasin has decreased considerably. Causes for the decline have included increased sediment loads due to roads, road building, other soil-disturbing activities, and decreased instream flows resulting from water diversions. Loss of shade due to removal of riparian vegetation has led to summer instream water temperatures no longer suitable for steelhead rearing. Several streams in the subbasin were listed in Oregon in 1998 under the Clean Water Act's Section 303(d) as stream segments with limited water quality. Big Creek, Cable Creek, Hidaway Creek, and the NFJD have been listed for having summer temperatures in excess of rearing temperatures suitable for salmonids. Portions of Cable Creek and Hidaway Creek have degraded habitat, primarily a lack of pools and large woody debris (BRT 2003).

The USFS manages 31% of the lands, much of it in the higher elevations within the subbasin. Wilderness areas within the subbasin include the North Fork John Day Wilderness, Strawberry Wilderness, Black Canyon Wilderness, and Bridge Creek Wilderness. Large portions of the SFJD and NFJD are managed by the BLM under the John Day River Management Plan, completed in 2001.

All steelhead numbers for the North Fork John Day (NFJD) are believed to be wild fish, given that the small amount of straying of hatchery fish in the John Day system occurs in the lower mainstem of the river.

The NFJD River from Camas Creek upstream to its headwaters was designated in 1988 under the Wild and Scenic Rivers Act of 1968 as either "Wild, Scenic, or Recreational," depending on the reach. Most of these reaches are on the Umatilla and Wallowa Whitman National Forests. The NFJD plus the MFJD contribute 60% of the flow to the mainstem John Day River. According to the Oregon Department of Environmental Quality (ODEQ), the NFJD has some of the best overall chemical, physical, and biological water quality in the John Day subbasin.

The ODEQ has identified several streams in the NFJD River watershed as water quality limited for sediment, high temperatures, and/or biological criteria, primarily because the lingering effects of vegetation disturbance, stream straightening/relocation, livestock grazing, timber harvest, road building, irrigation water withdrawals, and historical mining and dredging. In addition, fire suppression practices have affected both the composition and structure of forestlands in the subbasin. Use of ground-based logging equipment on steep (greater than 30%) slopes and high road densities have often contributed sediment to streams, negatively impacting steelhead spawning and rearing areas.

Past livestock management practices that resulted in high intensity riparian grazing and/or season-long use of riparian areas caused bank destabilization, excessive sedimentation, and increased stream temperatures, because the width-to-depth ratio of the channel was increased when livestock trampled banks, collapsing those that were undercut.

A high number of pushup dams have been used for irrigation, with some of these temporary dams having resulted in intermittent passage and interrelated impacts such as sedimentation, reduced flows, channel alteration, and associated water quality impacts (NWPPC 2001). Additionally, there are still many state-authorized water diversions that are unscreened or have screens that do not meet current NOAA Fisheries or state screen criteria (NWPPC 2001).

The Draft John Day Subbasin Plan (NWPPC 2004a) described the primary limiting factors for fish species (including steelhead) in the NFJD: temperature was identified as a limiting factor throughout the North Fork, flow, habitat diversity, sediment load, and key habitat quantity were also identified as limiting factors in all but one of the fifth-field watersheds, channel stability was identified as a limiting factor in over half of the fifth-field watersheds in the North Fork John Day subbasin.

NOAA Fisheries reviewed the relevant records of completed consultations and found three formal consultations for actions in the North Fork John Day subbasin (USGS HUC 17070202). These actions addressed Federal land grazing management and a suite of ecosystem projects with variable short and long-term effects on the following limiting factors in this subbasin, water quality and riparian condition.

No FCRPS Action Agency consultations were identified in this subbasin. Two consultations addressed Federal lands grazing management in a manner that would keep reach-scale habitat degradation to a minimum and improve aquatic habitat condition over the long-term on tributaries exposed to these Federal grazing actions. The Forest Service also recently completed consultation on Tower Ecosystem Restoration Projects (TERP). The activities proposed in the TERP included planting, trail relocation, slope stabilization, hazard tree removal, thinning, fencing, road repair, road obliteration/decommissioning, fish habitat improvement, soil compaction reduction, big game forage enhancement, recreation site rehabilitation, fuel reduction and wood fiber salvage, and herbicide application. NOAA Fisheries found that these actions will cause some short-term increases in stream turbidity and sedimentation rates in watersheds located within the action area. However, the actions are not expected to impair currently properly functioning habitats, appreciably reduce the functioning of already impaired

habitats, or retard the long-term progress of impaired habitats toward proper functioning habitat condition.

Based on this review, the consulted upon Federal actions will have slight, primarily beneficial effects on factors limiting listed salmonids at the reach scale in the North Fork John Day subbasin.

5.4.8.3.2 Middle Fork John Day River (USGS HUC 17070203). The 75 miles of Middle Fork John Day River (MFJD) drain approximately 506,853 acres, of which 53% are within USFS ownership. Since the 1960s, the USFS has conducted harvest activities on over 25% of its lands in the MFJD subbasin. Elevations range from 8,110 feet at its headwaters within the Elkhorn Mountains to 2,185 feet where it joins the Mainstem John Day River. Over 90% of the appropriated water in the MFJD subbasin goes to irrigation and mining, with half of the mining water rights being authorized post-1970. Within three subwatersheds of the MFJD (Galena, Upper Middle Fork, and Camp Creek), there exist a total of 113 mining sites: two tunnel mines, 39 placer claims, and 72 lode claims. Road density of this watershed is considered high, as it averages 3.56 mi/mi^2. The MFJD is listed under Oregon's Clean Water Act 303(d) as a water quality limited streams for high summer temperatures and flow modification (irrigation) (USDA 2001; NWPPC 2004a).

The John Day River probably represents the largest native, naturally spawning stock of steelhead in the region (NMFS 2000). All steelhead numbers for the Middle Fork John Day River are believed to be wild fish, given that the small amount of straying of hatchery fish that does occur in the John Day system occurs in the lower mainstem of the river. The NFJD plus the MFJD contribute 60% of the flow to the mainstem John Day River. The area historically supported healthy riparian and upland areas, good water quality, and a natural hydrograph.

ODEQ has identified several streams in the MFJD River watershed as water quality limited for high temperatures, dissolved oxygen, or biological criteria, with the most serious water quality problem being elevated summer temperatures caused by lingering effects of vegetation disturbance, stream straightening/relocation, livestock grazing, timber harvest, road building, irrigation water withdrawals, and historical mining and dredging. In addition, fire suppression practices have affected both the composition and structure of forestlands in the subbasin. Use of ground-based logging equipment on steep (greater than 30%) slopes and high road densities has often contributed sediment to streams, negatively impacting steelhead spawning and rearing areas.

Past livestock management practices that resulted in high intensity riparian grazing and/or season-long use of riparian areas caused bank destabilization, excessive sedimentation, and increased stream temperatures, because the width-to-depth ratio of the channel was increased when livestock trample banks, collapsing those that are undercut. Lingering effects of heavy and often summer-long grazing has resulted in several areas in the upper reaches of the MFJD River, a lack of adequate riparian vegetation and shrubs necessary to prevent bank erosion and an increase of instream water temperatures.

A high number of pushup dams have been used for irrigation. Some of these temporary dams have resulted in intermittent passage and interrelated impacts such as sedimentation, reduced flows, channel alteration, and associated water quality impacts (NPPC 2001). Additionally, there still exist many legal water diversions which remain unscreened or have screens that do not meet current NOAA Fisheries screen criteria (NPPC 2001).

Many parts of the mainstem Middle Fork were dredge-mined (particularly near Galena at RM 45 and near the mouth of Granite Boulder Cr at RM 57), and several tributaries (such as Davis, Vincent, Vinegar, Ruby, Ragged and Butte creeks, among others) were placer-mined.

The Draft John Day Subbasin Plan (NWPPC 2004a) described the primary limiting factors for fish species (including steelhead) in the MFJD: flow, habitat diversity, temperature, and key habitat quantity were identified as limiting factors throughout the Middle Fork John Day River, sediment load and channel stability were found to be limiting factors in all but one of the fifth-field watersheds.

NOAA Fisheries reviewed the relevant records of completed consultations for this subbasin and found four formal and informal consultations completed for actions in the Middle Fork John Day (USGS HUC 17070203). These actions addressed emergency fire suppression, grazing management on Federal lands, and culvert restoration with variable short and long-term effects on the following limiting factors in this subbasin, instream flow and passage.

Reclamation completed consultation on the Grant County SWCD Irrigation Diversion and Fish Passage Improvement Program. Reclamation coordinated with SWCD, CTWS to implement this action in subareas of the John Day mainstem, MFJD, as well as Camp Creek and Long Creek of MFJD. A total of 14 actions were proposed including elimination of 3 push-up berms; open ditch conversion to pipeline; installation of 4 infiltration galleries; 2 lay-flat stanchion diversions; and 2 miles of riparian fencing. This project is likely to improve flow and passage conditions with some benefit to riparian condition. Two consultations addressed Federal lands grazing management in a manner that would keep reach-scale habitat degradation to a minimum and improve aquatic habitat condition over the long-term on tributaries exposed to these Federal grazing actions. The Forest Service also consulted on the Blue Culverts Project, Malheur National Forest; an action to replace or improve six road crossings to facilitate fish passage and to restore natural stream- channel morphology at the crossings. The action is expected to reduce chronic sediment inputs in the long term, improve fish passage in the action area, and maintain the current condition of all other relevant habitat indicators. An emergency fire suppression action with minimal effects was also listed for this subbasin.

Based on this review, the consulted upon Federal actions will have slight, primarily beneficial effects on factors limiting listed salmonids at the reach scale in the Middle Fork John Day subbasin. In the aggregate, the distribution and scope of these projects will not measurably affect the status of the environmental baseline in this portion of the action area.

5.4.8.3.3 John Day River Upper Mainstem and South Fork John Day (USGS HUC 17070201). The upper mainstem John Day River area historically had healthy riparian and upland areas,

good water quality, and a natural hydrograph. Much of the degradation tied to mining activities is not associated with current activities.

ODEQ has identified several streams in the Upper John Day River and the SFJD River watershed as water quality limited for high temperatures, dissolved oxygen, or biological criteria, with the most serious water quality problem being elevated summer temperatures caused by lingering effects of vegetation disturbance, stream straightening/relocation, livestock grazing, timber harvest, road building, and irrigation water withdrawals. In addition, fire suppression practices have affected both the composition and structure of forestlands in the subbasin.

The lingering effects of agricultural practices have changed hydrology, contributing to degraded stream and riparian conditions throughout the subbasin. Draining and conversion of wetlands to pastures, diking and channelization of streams, and removal of extensive beaver colonies and large trees in the riparian corridor have all had negative effects on the river's interaction with its floodplain (NWPPC 2004a).

Steelhead in the upper mainstem have become seasonally isolated due to high water temperatures and reduced flows in the connecting mainstems. Multiple agricultural diversions on Strawberry Creek have prevented all upstream fish passage. A section of Indian Creek has been virtually dewatered during the summer.

Mining activity in the upper mainstem John Day River was extensive in the past and included large-scale dredging of the upper John Day River and lode mines in the Canyon Creek watershed and above Prairie City. Although active claims exist in a number of tributaries, the majority of current activity consists of small-scale placer mining along area streams, such as Canyon Creek. It is believed that if the price of precious metals increased significantly, mining activities would increase, as well.

All steelhead numbers for the South Fork John Day are believed to be wild fish, given that the small amount of straying of hatchery fish that does occur in the John Day system occurs in the lower mainstem of the river.

The South Fork John Day River from Smokey Creek upstream to the Malheur National Forest boundary was classified in 1988 as “Recreational” under the Wild and Scenic Rivers Act of 1968 and is managed by BLM. The area historically supported healthy riparian and upland areas, good water quality, and a natural hydrograph. However, habitat condition has been degraded.

The ODEQ has identified several streams in the Upper John Day River and the SFJD River watershed as water quality limited for high temperatures, dissolved oxygen, or biological criteria, with the most serious water quality problem being elevated summer temperatures caused by the lingering effects of vegetation disturbance, stream straightening/relocation, livestock grazing, timber harvest, road building, and irrigation water withdrawals. In addition, fire suppression practices have affected both the composition and structure of forestlands in the subbasin.

The Draft John Day Subbasin Plan (NWPPC 2004a) described the primary limiting factors for fish species (including steelhead) in the SFJD: key habitat quantity, flow, and temperature were

the greatest limiting factors on the South Fork John Day River. These factors were rated as moderate or high, channel stability, habitat diversity, and sediment load were also severe limiting factors. Half of the fifth-field watersheds were rated high for all three of these factors, and obstructions range from high to low throughout the South Fork John Day River, averaging moderate.

NOAA Fisheries reviewed the relevant records of completed consultations for this subbasin and found 13 formal and informal consultations completed for actions in the Upper John Day (USGS HUC 17070201). These actions addressed fire suppression, timber management, grazing management, water diversions and habitat restoration. These projects are expected to have varying short- and long-term effects on instream flow, passage, and riparian conditions.

BPA, in cooperation with the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO), was the lead agency on three consultations in the Upper John Day subbasin:

- In 2002, consulted on the proposed John Day Watershed Program 2002. All of the proposed projects were improvements to irrigation diversions or to existing irrigation systems. NOAA Fisheries expects actions that will replace gravel push-up berms with infiltration galleries to lead to improved fish passage conditions. These will benefit both juveniles rearing in these reaches, which are swimming upstream to find cool water in the spring, and out-migrating smolts. There may be short-term negative effects of sedimentation in the various watersheds, but fish passage will be improved (long-term benefit) at many of the project sites.

- In 2003, consulted on nine projects to improve fish passage and other habitat features while continuing to provide irrigation for legal water withdrawals. Although these projects are expected to have short-term negative effects on the stream, the long-term reach-level effects should improve conditions.

- In 2004, consulted on actions to construct four permanent diversion structures to eliminate the need for annual push-up gravel berms, and to install a pumping station to eliminate the need for an annual push-up gravel berm. The diversion structures and pump station are designed to improve the effectiveness of the diversion while providing fish passage and eliminating the need for annual streambed disturbance from reforming the push-up berms. The proposed action is expected to improve habitat access and reduce chronic sedimentation and passage will be provided at diversion structures, which may have been partial barriers in the past.

NOAA Fisheries has completed seven consultations on grazing management with the Forest Service and Bureau of Land Management. Actions in these consultations contain conservation measures for FS and BLM grazing programs on tributary streams sufficient to keep reach scale habitat degradation to a minimum and to provide long-term improvements to aquatic habitat indicators such as water temperature, sediment, substrate embeddedness, width/depth ratio, and streambank condition on tributary streams. BLM also completed consultation on the Little Canyon Mountain Timber Sale and Stewardship Project. This action included fuels reduction, road relocation and resurfacing, road closures and culvert replacement. This project will have a

long-term, positive effect on habitat condition delineated by this action. Restoring access to a watershed that MCR steelhead currently attempt to use is expected to increase the abundance of spawners and to benefit the population's spatial structure. Other consultations included one with the Farm Service Administration for a CREP project. Lastly, a USFS emergency fire suppression action with minimal effects completed consultation.

Based on this review, the consulted upon Federal actions will have slight, primarily beneficial effects on factors limiting listed salmonids at the reach scale in the Upper Mainstem John Day and South Fork subbasins. In the aggregate, the distribution and scope of these projects will not measurably affect the status of the environmental baseline in this portion of the action area.

5.4.8.3.4 Umatilla River (USGS HUC 17070103). The USBR developed the Umatilla Project in 1906 and Umatilla Basin Project in 1988, and these projects directly influence the lower 52 miles (from MacKay Creek downstream) of the Umatilla River. There are multiple systems of canals, pumping stations, and storage reservoirs that make up USBR's Umatilla and Umatilla Basin Projects.

It is important to note, however, that the steelhead population was much higher in earlier years and was severely impacted by heavy water withdrawals for agricultural purposes that began in the early 1900s. The Confederated Tribes of the Umatilla Indian Reservation (CTUIR 2001) report that a limited amount of high quality salmonid habitat persists, especially at higher elevations.

Lingering effects of cultivation, grazing, forestry, urban development, and water storage and diversion for irrigation and flood control have dramatically degraded aquatic habitats throughout the Umatilla subbasin. The draft Umatilla/Willow Subbasin Plan (NWPPC 2004c) characterized the watershed as having inadequate stream flows, excessive temperatures, excessive erosion, simplified and reduced instream habitat, and inadequate riparian cover. Many of the streams in the Umatilla Basin are on the Clean Water Act (CWA) 303(d) list for temperature, sediment, and nutrients (ODEQ 2001).

Agricultural, rangeland, and forestland practices and urban development have led to widespread changes throughout the basin. The most significant vegetation change has been the disappearance of large forested riparian areas along the Umatilla River and the conversion of native prairie to farmland (Kagan *et al.* 2000). ODEQ (2001) estimates that bottomland hardwood and willow communities have been reduced by 87% since 1850, and NPCC (2004) reports that 70% of all Umatilla River tributaries need riparian improvement.

Large-scale water developments by USBR have altered natural stream flows through water storage and irrigation diversions. Summer withdrawals have annually subjected large sections of the lower Umatilla River to extremely low flow conditions that have often reduced the river to a series of disconnected pools (USBR 2001). ODEQ (2001) also reports the lack of water in many basin areas where the original General Land Office surveyors reported abundant springs and small creeks. Additionally, the NPCC (2004) reports that dikes, levees, and rip-rapped banks have straightened and channelized streams in many parts of the subbasin.

Many point and non-point pollution sources have contributed to poor water quality within the basin. Point sources have included five wastewater treatment plants that release effluent into the mainstem Umatilla. Non-point sources have included urban and agricultural run-off laced with hydrocarbons, pesticides, and fertilizers. High sediment levels and turbidity from streambank erosion and from the lingering effects of agricultural practices on highly erodible soils have further degraded water quality.

Reduced riparian shading, increased channel width/depth ratios, reduced flows, and irrigation return flows have all contributed to elevated stream temperatures. ODEQ found that Umatilla Basin stream temperatures have often exceeded state water quality standards between June and September. Water diversions, land use practices, and stream channelization have reduced side channel access, habitat diversity, rearing space, food production areas, and longitudinal connectivity along stream courses (ODEQ 2001).

In April 2004, NOAA Fisheries transmitted a biological opinion and Magnuson-Stevens Fishery Conservation and Management Act (MSA) essential fish habitat (EFH) consultation on Bureau of Reclamation Ongoing Operation of the Umatilla Project and the Umatilla Basin Project, Columbia River, Umatilla River, and McKay Creek (refer to NOAA Fisheries No.: 2001/01415). NOAA Fisheries concluded that the environmental baseline conditions that resulted from the past operation and maintenance of the Umatilla Basin Project would be maintained and continued but that any adverse effects from USBR's operation and maintenance of the Umatilla Basin Project were unlikely to be of a magnitude, duration, or extent that would reduce the long-term survival of MCR steelhead. There will be no measurable change in the status of the environmental baseline in this portion of the action area.

5.4.8.4 Harvest Rates

As indicated above, in order to estimate the extent of the baseline treaty harvest, NOAA Fisheries will presume that treaty and non-treaty harvest rates comparable to the current harvest rates will continue into the future pursuant to Court-approved settlement agreements. Mainstem harvest rates for MCR steelhead salmon are set forth in the 2001 Interim Agreement on winter/spring/summer fisheries (Table 5.3).

5.4.8.5 Artificial Propagation Programs

Future artificial propagation operations as described in Section 5.3.5 are part of the environmental baseline.

5.4.9 Upper Willamette Steelhead

5.4.9.1 Mainstem

Juvenile UWR steelhead migrate as yearlings, entering the action area at the mouth of the Willamette River, at approximately RM 100 in the lower Columbia River during spring. The primary factors affecting the status of this stream-type ESU as juveniles move through the estuary and plume have been avian predation and flow (Section 5.3.1; Fresh *et al.* 2004). The

status of biological requirements for water quality, quantity, and velocity in adult migration corridors is the same as those discussed for SR spring/summer chinook salmon (Section 5.4.1).

5.4.9.2 Tributary Habitat Conditions

The action area for Upper Willamette River steelhead includes all tributary subbasins to which adult fish return and therefore are potentially affected by a reduction of marine-derived nutrients. The Tualatin subbasin contains one of the 19 USBR consultations included in the UPA (Appendix C, UPA 24 November 2004). This subbasin is generally representative of conditions in the remaining subbasins with similar habitat and land use. Appendix E, the Limiting Factors Analysis, prepared to guide the development of the UPA, further informs this evaluation of the environmental baseline in the tributary habitat. The subbasins occupied by this ESU in addition to the Tualatin discussed below are evaluated in Appendix E. For the purposes of this biological opinion, the effects of this representative subbasin, described below, is extrapolated to all subbasins

5.4.9.2.1 Tualatin (USGS HUC 17090010). The Tualatin subbasin covers an area of 707 square miles on the eastern slope of the Coast Range and the floor of the Willamette Valley. The Tualatin River is approximately 80 miles long and enters the Willamette River at RM 29. Approximately 93 percent of the land in the subbasin is privately owned. Most of the private lands are in forestry, agricultural, rural residential, and urban land uses. About half of the subbasin is forested (Murtagh et al., 1992). Urban lands cover a substantial portion of the lower subbasin, including the cities of Forest Grove, Tigard, Lake Oswego, and West Linn and the southwest portion of Portland. The Salem District of the BLM and the Oregon Department of Forestry manage a small portion of the upper subbasin. The Tualatin River, primarily in Gales Creek, has a small number of naturally spawning winter steelhead. There is evidence that winter steelhead are native to the subbasin, but they are not considered a self-sustaining population (Myers et al., 2003). Lower Columbia River coho are also resident to the subbasin although their historical reliance on the subbasin is uncertain (Myers et al., 2003). In addition, juvenile chinook salmon have been observed using the lower portions of the river as rearing and winter refuge habitat. Cutthroat trout exist in all of the subbasin's streams, and historically there was a population that moved between the river and the Willamette River mainstem (Murtagh et al., 1992).

The Tualatin River's headwaters are on the forested east side of the Coast Range. The river's headwaters flow through private industrial, state, and federal forestlands, small-acreage farms, and rural residential areas until the river reaches the floor of the Willamette Valley near Cherry Grove (RM 68). Major tributaries in the forested upper subbasin include Scoggins, Gales, and Dairy creeks. In the lower subbasin, the Tualatin River flows through agricultural lands and scattered rural residential areas and near numerous small communities and cities. McKay, Rock, and Fanno creeks are major tributaries in the lower subbasin.

The headwaters of the Tualatin River and tributaries of the upper subbasin flow steeply off the Coast Range. After the river and tributaries enter the Willamette Valley the gradient decreases and the river meanders through the alluvial deposits of the Willamette Valley. These low-

gradient areas in the lower subbasin create reaches with slow-moving water that are prone to high temperatures during the summer and early fall (Murtagh et al., 1992).

In the Tualatin subbasin, the productivity, capacity, and diversity of juvenile chinook salmon populations have been limited by the following factors: habitat connectivity, including the lingering effects of modification of river and tributary habitat through channel and bank confinement and reduced large wood in the channels which has interacted to reduce floodplain connectivity and backwater habitats important for juvenile salmon rearing and winter refuge; habitat modification, modification of key aquatic habitats affecting all life stages; large wood, changes in the delivery and transport of large wood in the river and tributaries has modified gravel deposition patterns, reduced the frequency and depth of pools, and minimized hiding cover and affected juvenile salmon rearing areas in the lower river; water temperature, increased summertime water temperatures have limited the capacity of river and tributary streams to support juvenile fish; and fish passage barriers, fish passage barriers at road crossings on tributary streams have limited adult and juvenile access into rearing and refuge habitat. Additional factors have included competition with introduced fish, runoff of toxics from urban and agricultural areas, and some unscreened water diversions.

5.4.9.3 Harvest Rates

As indicated above, in order to estimate the extent of the baseline treaty harvest, NOAA Fisheries will presume that treaty and non-treaty harvest rates comparable to the current harvest rates will continue into the future pursuant to Court-approved settlement agreements. Mainstem harvest rates for UWR steelhead salmon are set forth in the 2001 Interim Agreement on winter/spring/summer fisheries (Table 5.3).

5.4.9.4 Artificial Propagation Programs

Future artificial propagation operations as described in Section 5.3.5 are part of the environmental baseline.

5.4.10 Lower Columbia River Steelhead

5.4.10.1 Mainstem

Juvenile LCR steelhead are yearling migrants, moving through the mainstem lower Columbia River during spring. Smolts emerging from the Hood and Wind rivers pass Bonneville Dam. The status of biological requirements for this ESU related to mainstem habitat and in the estuary and plume is discussed for SR spring/summer chinook salmon (Section 5.4.1). The status of biological requirements for water quality, quantity, and velocity in adult migration corridors is also the same as those discussed for SR spring/summer chinook salmon (Section 5.4.1).

Table 5.1 shows the estimated juvenile in-river survival through the lower Columbia River reach in the reference operation ranged from 65 to 97% during 1994-2003 with a mean of over 86%. These estimates indicate that the habitat-related biological requirements of juveniles, as described in Section 5.4.1.2, are not being fully met. These Hood and Wind River population

estimates are lower than estimated survival through free-flowing river sections, which is assumed to approximate the survival rate associated with properly functioning habitat conditions. Table 5.1 shows the updated estimate of the mean free-flowing survival from 1995-2003 is 99.1% (Ferguson 2004).

Average adult survival shown in Table 5.2 is 97.4% for populations passing Bonneville Dam (Appendix D).

5.4.10.2 Estuary and Plume Habitat Conditions

The status of the habitat in the estuary and plume for this yearling-type ESU is the same as that described for SR spring/summer chinook salmon (Section 5.4.1.2).

5.4.10.3 Tributary Habitat Conditions

The action area for Lower Columbia River steelhead includes all tributary subbasins to which adult fish return and therefore are potentially affected by a reduction of marine-derived nutrients. The Action Agencies have not proposed offsetting measures for effects of the hydrosystem on tributary habitat used by this ESU. Conditions under the environmental baseline in those subbasins occupied by this ESU are described in Appendix E and incorporated here by reference.

5.4.10.4 Harvest Rates

As indicated above, in order to estimate the extent of the baseline treaty harvest, NOAA Fisheries will presume that treaty and non-treaty harvest rates comparable to the current harvest rates will continue into the future pursuant to Court-approved settlement agreements. Mainstem harvest rates for LCR steelhead salmon are set forth in the 2001 Interim Agreement on winter/spring/summer fisheries (Table 5.3).

5.4.10.5 Artificial Propagation Programs

Future artificial propagation operations as described in Section 5.3.5 are part of the environmental baseline.

5.4.11 Columbia River Chum Salmon

5.4.11.1 Mainstem

Juvenile CR chum salmon are subyearling migrants, moving through the mainstem lower Columbia River during late winter and early spring. The status of biological requirements of juvenile chum salmon for water quality in the mainstem migration corridor is the same as those discussed for SR spring/summer chinook salmon (Section 5.4.1). Although chum salmon spawned historically in the lower reaches of several tributaries to the Bonneville pool and along the Washington shoreline, this habitat was inundated by the Bonneville pool in 1938 (Fulton 1970). Spawner surveys since 2000 have seen only one adult chum salmon carcass in this area

(Big White Salmon River). Thus, it is possible but unlikely that any year class is affected by project passage.

Water stored in upper Columbia River reservoirs can be used to augment mainstem flows below Bonneville Dam, creating access to and increasing the extent of spawning habitat in the Ives Island area. Hydro system reservoir operations do not affect temperatures in the Ives Island area during November and December, when chum salmon spawn.

In the reference operation, both flow and spill operations at Bonneville Dam are managed to protect chum salmon. Beginning in late October and continuing through March, operations are provided in the reference operation to maintain minimum tailwater elevations at Bonneville to establish and protect redds, although the extent of these operations depends on the ability to implement other seasonal operations. Efforts are also made to limit spill to a level, and/or provide higher flows for depth compensation, which would not exceed 105% TDG over established redds. These efforts to protect chum also confer protection to established LCR chinook redds and emergent fry.

Adult CR chum salmon do not have biological requirements for food, cover, shelter, or riparian vegetation associated with spawning habitat. Reservoir storage does not affect temperatures in the Ives Island area during November and December, when chum salmon spawn.

The primary factors affecting the status of this ocean-type ESU as juveniles move through the lower Columbia River have been flow and the associated reduction of shallow-water habitat (Section 5.4.1.2; Fresh *et al.* 2004).

5.4.11.2 Estuary and Plume Habitat Conditions

The status of the habitat in the estuary and plume for this subyearling-type ESU is the same as that described for LCR chinook salmon (Section 5.4.5.2).

5.4.11.3 Tributary Habitat Conditions

The action area for Columbia River chum salmon includes all tributary subbasins to which adult fish return and therefore are potentially affected by a reduction of marine-derived nutrients. The Action Agencies have not proposed offsetting measures for effects of the hydrosystem on tributary habitat used by this ESU. Conditions under the environmental baseline in those subbasins occupied by this ESU are described in Appendix E and incorporated here by reference.

5.4.11.4 Harvest Rates

As indicated above, in order to estimate the extent of the baseline treaty harvest, NOAA Fisheries will presume that treaty and non-treaty harvest rates comparable to the current harvest rates will continue into the future pursuant to Court-approved settlement agreements. Mainstem harvest rates for CR chum salmon are set forth in the 2001 Interim Agreement on winter/spring/summer fisheries (Table 5.3).

5.4.11.5 Artificial Propagation Programs

Future artificial propagation operations as described in Section 5.3.5 are part of the environmental baseline.

5.4.12 Snake River Sockeye Salmon

5.4.12.1 Mainstem

Juvenile SR sockeye salmon are yearling migrants, with peak movement past Lower Granite Dam during May. Although there are no empirical data, the primary factors affecting the status of this stream-type ESU as juveniles move through the estuary and plume have been likely to be avian and cormorant predation and flow (Section 5.3.1; Fresh *et al*. 2004). Due to similarities in the timing and size of fish at migration, NOAA Fisheries assumes that survival rates described for SR spring/summer chinook salmon (Section 5.4.1) can be used to generally characterize this ESU.

Average adult survival shown in Table 5.2 is 86%.

5.4.12.2 Estuary and Plume Habitat Conditions

The status of the habitat in the estuary and plume for this yearling-type ESU is the same as that described for SR spring/summer chinook salmon (Section 5.4.1.2).

5.4.12.3 Tributary Habitat Conditions

As described in Appendix E, habitat in the mainstem Salmon River between the confluences of the North Fork Salmon and Pahsimeroi rivers is limited by a modified hydrologic regime, inadequate pool/riffle ratios, and structural migration barriers (NWPCC 2004b). Tributaries have been disconnected by irrigation diversions that reduce instream flows and eliminate most thermal refugia used by sockeye salmon smolts migrating in the mainstem Salmon River between the cities of Salmon and Challis, Idaho. The natural hydrologic regime in the upper mainstem Salmon River has also been altered by water withdrawals. Effects include a reduction in base flow conditions and some modifications to flow timing (NWPCC 2004b). Sockeye survival declines significantly with decreases in mean flows in the Salmon River during May (Arthaud *et al.* 2004).

Sockeye salmon have entered irrigation systems when the systems are turned on before fish screens are in place, when diversions and control structures are in operation, and when there has been “backdoor access” provided by wastewater return flows and breeched ditches. Upon entering a hydrologically variable irrigation system, fish are subject to threats from dewatering such as increased temperatures, reduced forage, increased predation, and desiccation (NWPCC 2004b).

The diversion and subsequent return of irrigation water and reductions in riparian shading have represented the primary factors contributing to increased temperatures in the mainstem Salmon

River from the 12-mile section upstream to Challis (NWPCC 2004b). Along the Salmon River, the lingering effects of diking, alluvial groundwater pumping, and encroachment by residential and road development have reduced access to sloughs, side channels, and springs that are heavily influenced by cooler groundwater sources, compounding the thermal stresses of the mainstem and reducing the area of thermal refugia along the migratory route. Legacy forestry, and the lingering effects of irrigation, and grazing management actions and forestry practices have also contributed to major tributary warming, which in turn results in warming of the mainstem Salmon River. Chemical contamination including inputs of heavy metals and other toxics from historical and extant mining districts in the Yankee Fork and Panther Creek drainages may have also interfered with the extraordinary migrations and homing of the Redfish Lake population of Snake River sockeye salmon between Idaho and the Pacific Ocean.

5.4.12.4 Harvest Rates

As indicated above, in order to estimate the extent of the baseline treaty harvest, NOAA Fisheries will presume that treaty and non-treaty harvest rates comparable to the current harvest rates will continue into the future pursuant to Court-approved settlement agreements. Mainstem harvest rates for SR sockeye salmon are set forth in the 2001 Interim Agreement on winter/spring/summer fisheries (Table 5.3).

5.4.12.5 Artificial Propagation Programs

Future artificial propagation operations as described in Section 5.3.5 are part of the environmental baseline.

5.4.13 Lower Columbia River Coho Salmon

5.4.13.1 Mainstem

Lower Columbia River coho salmon migrate through the lower mainstem Columbia River both as yearling and subyearlings. The primary factors affecting the status of this ESU as juveniles move through the estuary and plume have varied with life history strategy (Fresh *et al.* 2004).

NOAA Fisheries does not know of any empirical information on survival through the Bonneville pool and dam for this ESU. However, assuming that survival is similar to that demonstrated by other yearling migrants such as SR yearling chinook, survival past Bonneville Dam in the reference operation is estimated to range from 87-94%, with a mean survival of over 91% Table 5.1). These estimates indicate that the habitat-related biological requirements of juveniles, as described in Section 5.4.1.2, are not being fully met. This estimated survival rate is lower than the estimated survival through a free-flowing river. Ferguson (2004) estimated free-flowing survival to be 95.5% for yearling chinook.

Recent (2001-2002) adult survival estimate, based on SR fall chinook per project survival rates, is 98.0% passing Bonneville Dam (Table 5.2 and Appendix D).

5.4.13.2 Estuary and Plume Habitat Conditions

The status of the habitat in the estuary and plume for this yearling-type ESU is the same as that described for SR spring/summer chinook salmon (Section 5.4.1.2).

5.4.13.3 Tributary Habitat Conditions

The action area for LCR coho salmon includes all tributary subbasins to which adult fish return and therefore are potentially affected by a reduction of marine-derived nutrients. The Tualatin subbasin contains one of the 19 USBR consultations included in the UPA (Appendix C, UPA 24 November 2004). This subbasin is generally representative of conditions in the remaining subbasins with similar habitat and land use. Appendix E, the Limiting Factors Analysis, prepared to guide the development of the UPA, further informs this evaluation of the environmental baseline in the tributary habitat. The subbasins occupied by this ESU in addition to the Tualatin are evaluated in Appendix E. For the purposes of this biological opinion, the effects of this representative subbasin is extrapolated to all subbasins.

5.4.13.3.1 Tualatin (USGS HUC 17090010). The status of the habitat in the Tualatin is described in section 5.4.9.2.1

5.4.13.4 Harvest Rates

As indicated above, in order to estimate the extent of the baseline treaty harvest, NOAA Fisheries will presume that treaty and non-treaty harvest rates comparable to the current harvest rates will continue into the future pursuant to Court-approved settlement agreements. Mainstem harvest rates for LCR coho salmon are set forth in the 2001 Interim Agreement on winter/spring/summer fisheries (Table 5.3).

5.4.13.5 Artificial Propagation Programs

Future artificial propagation operations as described in Section 5.3.5 are part of the environmental baseline.

5.5 ADEQUACY OF CONDITIONS IN DESIGNATED CRITICAL HABITAT

Essential features of designated critical habitat (i.e., for three ESUs of SR salmon) include substrate, water quality, water quantity, water temperature, food, riparian vegetation, access, water, velocity, space, and safe passage. The status of these features in currently designated critical habitat is described in Sections 5.4.1 (SR spring/summer chinook), 5.4.2 (SR fall chinook), and 5.4.12 (SR sockeye salmon).

The “safe passage” essential feature of FCRPS juvenile migration corridor critical habitat is of particular concern for all three ESUs, because the proposed action primarily affects this essential feature (Sections 6.3.1.3, 6.4.1.3, and 6.14.1.3). The likely purpose of safe passage, relative to “survival or recovery” of listed species, is survival through the migratory corridor sufficient to support increasing populations up to at least a recovery level. An indicator of the degree to which

safe passage is achieved under the reference operation is the estimate of the survival rate of juveniles that migrate through this habitat ("in-river survival" estimates in Table 5.1. Significant levels of juvenile in-river mortality are expected under the reference operation. The in-river survival rates necessary to achieve recovery are unknown at this time but are presumably higher than the in-river survival rates expected under the reference operation. For comparison, rough estimates of in-river survival rates that may have occurred under pre-dam conditions are displayed in Table 5.1. It is likely that expectations for recovery would not exceed these in-river survival rates.

For SR fall chinook salmon, shallow-water juvenile rearing habitat in the estuary is also of concern, because it is affected by the proposed action (Section 6.4.1.3). The likely purpose of shallow water estuarine habitat, relative to "survival or recovery" of listed species, is survival, growth, and physiological development in the estuary sufficient to support increasing populations up to at least a recovery level. As indicated in Section 5.2.2.2, the acreage of available shallow-water habitat has decreased over the past 60 years. The amount of shallow water estuarine habitat necessary for recovery of SR fall chinook salmon is unknown at this time but is presumably greater than the acreage that is currently available.

For adults of all three species, critical habitat appears adequate for safe passage, as indicated by survival rates and migration rates that are similar to those that would occur under free-flowing conditions. The adequacy of essential features of spawning habitat for SR fall chinook under the reference operation is uncertain. Historical spawning habitat has been inundated by some FCRPS reservoirs, although limited spawning in tailraces of SR dams does occur.

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