Baker River Hydroelectric Project

(FERC No. 2150)

Washington

BIOLOGICAL ASSESSMENT
OF PROPOSED INTERIM CONSERVATION MEASURES
FOR PUGET SOUND CHINOOK SALMON
PENDING RELICENSING

Puget Sound Energy, Inc.

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1. INTRODUCTION

The Baker River Project, FERC No. 2150 (the "Baker Project"), is owned and operated by Puget Sound Energy, Inc. ("PSE"). The Baker Project consists of two hydroelectric generating developments; both located on the Baker River, in Washington State. Construction of the Lower Baker Development, including the Lower Baker Dam at River Mile (RM) 1.1, was completed in 1925 prior to the enactment of the Federal Power Act. In 1927, the Federal Power Commission (now known as the Federal Energy Regulatory Commission or "FERC") issued a license to Puget Sound Power & Light Company (now known as PSE) to operate the Lower Baker Development. The Federal Power Commission subsequently issued a License in 1956 to construct the Upper Baker Development. The License combined the operations of both developments into a single federal license for the Baker Project (Figure 1-1). Construction of the Upper Baker Development, including the Upper Baker Dam at River Mile (RM 9.2), was completed in 1959.

The Baker Project license expires in 2006. PSE filed a notice of intent to relicense the Project in April 2001, and plans to file an application to relicense the Project on or before April 30, 2004. In advance of that filing, PSE (as the prospective license applicant) initiated informal consultation as the non-federal designee under Section 7 of the Endangered Species Act (ESA) with respect to relicensing of the Project. Under Section 7, "a federal agency shall consult with the Secretary [of Commerce or Interior, as appropriate] on any prospective agency action at the request of, and in cooperation with, the prospective permit or license applicant if the applicant has reason to believe that an endangered species or threatened species may be present in the area affected by his project and that implementation of such action will likely affect such species" 16 USC §1536(a)(3). There are several listed species in the Project Area, including chinook salmon (*Oncorhynchus tshawytscha*) within the Puget Sound Evolutionarily Significant Unit (ESU), listed as threatened (63 Federal Register 11482). Since 1990, an average of 343 adult chinook has returned to the Baker River trap each year. In the past eleven years, an average of 1,303 juvenile chinook salmon have been collected and transported downstream of the Baker Project.

Operation of the Baker Project affects flows in the lower 1.1 miles of the Baker River, and affects flows in the mainstem Skagit River downstream of RM 56.5. The mainstem Skagit River is also affected by operation of Seattle City Light's Skagit River Hydroelectric Project (FERC No. 553) (the "Skagit Project") located approximately 40 miles upstream of the Baker River's confluence with the Skagit River. Both the Baker Project and the Skagit Project are typically operated as load-following plants. Baker typically operates once or twice a day, usually during mornings (i.e., 0600 to 1000) and evenings (i.e., 1700 to 2100). These periods of operation vary daily, weekly and seasonally in response to power demands and power value. For instance, electrical demand is generally higher Monday through Friday and in response, the Project may not operate during the weekend. Daily peaking operations may cause flows in the Lower Baker River to fluctuate up to 4,200 cfs.

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Figure 1-1: Baker River Hydroelectric Project, Concrete, Washington

In the late fall 2000, NMFS and USFWS became concerned that generation by the Baker Project and Skagit Project supplemented flows in the Skagit River, causing fish to spawn at higher elevations, and that subsequently when water became scarce in the 2000-2001 drought, salmon redds were exposed for extended periods, resulting in egg desiccation. As an aspect of PSE's plans to pursue early Section 7 consultation on its proposed new license for the Baker Project, PSE undertook additional discussions to address matters of interest to the Services pending relicensing.

First, representatives of PSE and the Services, working with the Baker Committee, developed a proposed arrangement for near-term Baker Project operations to help mitigate the salmon production impact of the low instream flows resulting from the previous winter's unusually dry natural weather conditions. PSE, in consultation with the tribes and resource agencies, operated the Baker Project reservoirs to conserve and use water for fish protection during the winter months. To help minimize egg desiccation pending fry emergence, PSE, in consultation with resource agencies and tribes, operated the Baker Project to generate strategic "pulses" of water, pulsing flows to bathe the redds to help avoid or reduce egg desiccation during the drought. This allowed the Baker Project to provide up to a "periodic" incubation base flow of 7,600 cfs for long enough each day to keep eggs wet and unfrozen, when the natural Skagit River flow was significantly lower, and when continuous generation would have caused the Baker Project to run out of water. Following emergence, project generation and a maintenance outage were, again in consultation with resource agencies and tribes, completed in the manner deemed most advantageous to chinook and other fish resources under the circumstances.

Following on those efforts representatives of PSE, FERC and the Services have been working to develop a plan of operations for the Project pending relicensing on a going-forward basis, in coordination with or taking account of the Skagit Project operations, in a manner that optimizes, to the extent possible, the power benefits of Skagit system hydroelectric operations (particularly in light of the current energy supply situation) while at the same time minimizing any effects of PSE's (and Seattle City Light's operations) on listed species. While the previous year's drought figured prominently in these discussions, they have also considered operational scenarios to address more "normal" and "wet" weather conditions, and particularly how the project's flood control capabilities could be brought to bear to help protect and recover Puget Sound chinook salmon.

The ESA serves to identify and provide mechanisms to protect species of plants and animals, which are considered to be threatened with or in danger of extinction. The law is administered by the U.S. Fish and Wildlife Service (USFWS), a subunit of the Department of Interior, for terrestrial plants, animals and resident fish, and by the National Marine Fisheries Service (NMFS), a subunit of the Department of Commerce, for marine animals and anadromous fish. These two agencies are often collectively referred to as "the Services." Listed species are present in the Project area. As an aspect of relicensing, the federal agency responsible for licensing the Baker Project, FERC, will be required to document in a biological assessment the degree to which the proposed action may adversely affect any threatened or endangered species found in the proposed project area or destroy or adversely modify designated critical habitat. The agency makes a determination of the biological effects of the action. In response, the Services will either concur with the assessment or prepare a Biological Opinion (BO), which first determines whether the adverse effects of an action would jeopardize the continued existence of any species or destroy or adversely modify designated critical habitat of the species and, if so, whether the action agency could avoid causing jeopardy or such destruction or adverse modification of critical habitat by pursuing reasonable and prudent alternatives. Thereafter (assuming the action or reasonable prudent alternatives to the action will not jeopardize the continued existence of the species), the Services identify reasonable and prudent measures (RPM) to minimize the impact of incidental taking of the species, and describes the terms and conditions that must be complied with by the Federal agency or applicant, or both, to implement the measures.

By letter dated March 5, 2001, the FERC authorized PSE to act as its non-federal designee in consultation with the Services, subject to limitations described in the Commission's order. In that capacity, and in consultation with representatives of the FERC and the Services, PSE has developed the proposed operational protocols, described in an "Interim Protection Plan contained in Sections 4.4 through 4.7, which follow," to act as interim measures to minimize impacts to Puget Sound chinook salmon pending relicensing of the Baker Project. As non-federal designee, PSE recognizes the Commission's objectives of compliance with the ESA with the goal of ensuring protection and contributing to recovery of listed species pending its relicensing decision and the Services' authorization for incidental take associated with such operations under Section 7 of the ESA for such interim period. In developing the interim protection plan, PSE is also mindful of the Commission's directive that Licensees assure that energy supplies are maintained, where possible increased, and safeguarded. E.g., Removing Obstacles to Increased Electric Generation and Natural Gas Supply in the Western United States, (94 FERC 61,272) and Extraordinary Expenditures Necessary to Safeguard National Energy Supplies, Docket No. PL01-6- 000 (96 FERC _ 61,299, issued September 14, 2001).

Information provided in this document describes baseline information about the Baker Project and its operations (Section 2) and the status of chinook salmon and habitats affected by the Baker Project (Section 3). Regulatory process issues, such as the scope of the proposed action are also described in Section 3, while Section 4 contains a description of proposed interim conservation measures. The environmental analyses, including a description of the environmental resources in the project area and the effects of the project on those resources, are described in Section 5. Section 6 contains analyses of Interrelated, Interdependent and Cumulative Effects. A summary of the Effects Analyses is contained in Section 7. In addition to analyses and discussions conducted as part of section 7 consultations, a number of environmental studies are also being conducted as part of the FERC relicensing effort. These studies will allow a more complete understanding of the status and needs of chinook salmon in the Baker and Skagit Rivers to inform the discussions and decisions regarding relicensing of the Baker Project, including further ESA consultation regarding terms and conditions that should be included in the new license.

As this assessment is being prepared, several matters are under consideration by NMFS. By federal register notice 67 FR 6215, NMFS has found that there is substantial scientific and commercial information indicating, in light of the Alsea Valley v. NMFS decision, that a change in the status of the listed Puget Sound chinook salmon ESU may be warranted (in the Skagit River the Puget Sound chinook salmon ESU includes both listed chinook and unlisted hatchery populations that are nevertheless within the ESU). Depending on the results of the reassessment, changes to this BA may be warranted.

2. PROJECT DESCRIPTION

PSE's Baker Project is located in the Baker River Basin on the west side of the Cascade Mountains in Washington State. The Baker River, the second largest tributary to the Skagit River, originates in the glacial fields of Mount Baker and Mount Shuksan and has an average annual flow of 2,667 cubic feet per second (cfs) (USGS Gage No. 12193500, period of record 1911-14, 1944-2000). The basin, which is largely uninhabited, is located within a very steep, mountainous region on the west side of the Cascade Mountains. The Baker Project consists of two major hydroelectric developments, Lower and Upper Baker.

2.1 LOWER BAKER DEVELOPMENT

The Lower Baker Development consists of the Lower Baker Dam, a powerhouse, reservoir and associated facilities. Lower Baker Dam is located on the Baker River approximately 1.1-miles north of the confluence of the Baker and Skagit Rivers. The powerhouse contains a single generating unit (Unit 3). The single turbine was replaced in the spring of 2001 and the new unit has a maximum machine flow of approximately 4,700-cfs and is capable of producing 77 megawatts (MW) of electricity. However, the maximum generating flow is currently limited to 4,200-cfs due to limitations of the transformer. Unit 3 efficiently operates at flows between 3,700 cfs to 4,100 cfs at a net head of 253 feet, and has a minimum machine flow of approximately 3,200 cfs (Figure 2-1).

Under current operations, water in the lower Baker River passes through the single power-generating unit at Lower Baker Dam, through a 24-inch bypass pipe (80 cfs), leakage through pressure relief holes in dam abutments, or is spilled through the Lower Baker Dam over the spillway crest at elevation 425-feet. When Lower Baker Unit 3 shuts down, an 80-cfs flow is continually released below Lower Baker through the 24-inch bypass valve to allow operation of the adult trap-and-haul facility. During periods of peak sockeye adult migration (i.e., late June through July), PSE has typically generated for 4 hours beginning at daylight into the Lower Baker River to provide additional attraction for adult fish staging at the confluence of the Baker and Skagit Rivers.

Lake Shannon, the reservoir formed by Lower Baker Dam, is approximately seven miles long and covers an area of about 2,200 acres at normal full pool (elevation 438.6 feet). Approximately 160,000 acre-feet of water are stored in Lake Shannon at full pool, including about 123,000 acre-feet of active storage above the minimum generation level. The top of Lower Baker Dam is at elevation 447 feet, and water is released through the turbine intake (elevation 355 feet) or through the dam spillway (spillway crest elevation 425 feet). Under normal operating conditions, Lake Shannon is held at full pool during the summer months. Minimum reservoir elevations are typically attained from November through March or early April. Lake Shannon can be operated in coordination with Baker Lake to provide flood control protection, but there is no formal agreement governing Lake Shannon operations for storage of winter storm runoff.

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Figure 2-1: Schematic of Lower Baker Development

2.2 UPPER BAKER DEVELOPMENT

The Upper Baker Development consists of the Upper Baker Dam, a powerhouse, reservoir and associated facilities. The Upper Baker powerhouse contains two generating units (Units 1 and 2) with a collective capacity of about 94 MW and a collective maximum machine flow of approximately 5,100-cfs. Baker Lake, the reservoir formed by Upper Baker Dam, is approximately nine miles long and covers an area of about 4,800 acres at normal full pool (elevation 724.0 feet). Roughly 285,000 acre-feet of water are stored in Baker Lake at full pool, of which approximately 185,000 acre-feet is active storage above the minimum generating pool (Figure 2-2). The top of Upper Baker Dam is at elevation 732 feet and water is released through the turbine intakes (elevation 655 feet) or through the spillway (spillway crest elevation 694 feet). Under normal operating conditions, Baker Lake is held near full pool during the summer months. Minimum reservoir elevations are typically attained from November through March or early April. PSE's license obligates PSE to operate the Upper Baker Development to provide the United States Army Corps of Engineers (the "Corps") with 16,000 acre-feet of flood control storage between November 1 and March 1. In addition, PSE is obligated to provide up to 84,000 acre-feet of additional flood control storage if requested by the Corps (for a total of up to 100,000 acre-feet of flood control storage). Under the current agreement between PSE and the Corps, PSE must maintain Baker Lake elevations at or below 720.75 by November 1 (to provide a total of 16,000 acre feet of flood control storage at the Upper Baker Development) and to elevation 707.8 feet or lower under normal operating conditions from November 15 to March 1 (to provide a total of 74,000 acre-feet of flood control storage at the Upper Baker Development).

2.3 BAKER PROJECT FISH FACILITIES

The upstream and downstream fish passage facilities at the Baker Project provide the opportunity for movement of anadromous fish between the Baker River above and below (and from within) the Baker Project. Anadromous fish leave the Baker River, travel out the Skagit River to Puget Sound and the ocean, and return again via the Skagit River to the Baker River. Fish passage at the Baker Project consists of three separate facilities: 1) the barrier dam and adult fish trap; 2) Lower Baker downstream fish passage; and 3) Upper Baker downstream fish passage.

An upstream trap and haul fish passage facility (i.e., barrier dam, fish trap, holding ponds and fish lift) has operated at the Baker Project since 1926 near RM 0.25. The small barrier dam blocks adult fish from continuing upstream and helps guide them into a trapping facility, where they are lifted into a tank truck for transport to different locations depending on the species (Figure 1-1). Between 1926 and 1995, an average of 9,400 adult salmon and steelhead have been counted at the Baker River trap on an annual basis. Fish are collected at the barrier dam using an adult trap where they pass through the entrance vestibule into a series of three holding ponds. Adults are sorted and evaluated in the uppermost pond, which contains a brail that can be mechanically raised or lowered, and moved into the hopper. From the hopper, fish are transferred to the transport truck for release. The bottom of the hopper is designed to seat securely with the top of the transport truck for a water-to-water transfer. The trap is typically operated year-around, except for a brief maintenance/repair period in May or June.

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Figure 2-2: Schematic of Upper Baker Development

Downstream migrating fish are collected at Lower and Upper Baker using a barrier net guidance system, attraction barge and fish trap/sampling facility. Juvenile fish moving downstream through the reservoir encounter the barrier net and move towards the attraction barge, also known as the 'gulper'. Pumps mounted on the attraction barge create a flow net attracting migrating fish towards the barge entrance. The mouth of the Upper Baker barge entrance is 12 feet wide by 9 feet high. Total flow entering the gulper barge is 70,000 gallons per minute (gpm). There are two primary pumpback pumps each rated at 35,000 gpm at 5 feet head and are driven with a 75 hp motor. Wooden louvers, with approximately 1/2- to 1-inch clear spacing (depending on location), are on the floor and sidewalls throughout the 42-foot length. The floor of the barge entrance is initially flat but gradually slopes up over a distance of 42 feet. At the downstream end, the floor gradually narrows to a 3-foot wide chute. Excess water drawn by the pumps is passed through the louvers and discharged on either side of the barge. Approximately 6,000 gpm enter the chute with up to 4,500 gpm pumped back to the reservoir. The remaining 1,500 gpm transport the fish transported to the holding and transportation barge. The Lower Baker Gulper is similar to the Upper Baker facility though smaller in scale (40,000 gpm). The gulpers are normally put in operation in March and run through end of July.

The barrier guide net systems at both Lower and Upper Baker are constructed of 1/4-inch, square mesh netting and are designed to extend completely across the forebay. The net is anchored to the bottom of the reservoirs with weights and an airline from the collection barge is attached to a flexible pipeline at the top of the nets acting as a corkline to maintain flotation and form a seal of the net to the surface. During conditions of impending spill, the flexible pipeline is flooded submerging the top section of the nets to reduce drag during spill events. After the spill event, the pipeline is evacuated of water refloating the nets to restore the barrier provided by the guide net system.

Downstream migrants are captured, sampled for biological information, transferred to a tank trailer and trucked to the mouth of the Baker River where they are released. During the 5-year period 1995 to 1999, an average of 200,247 smolt-sized juvenile salmonids per year have been transported downstream from the Upper and Lower Baker Developments. Some juvenile anadromous salmonids may also pass over the spillways or through the turbines. During the 1950s, the results of research indicated that sockeye smolts passing over the spillway at Lower Baker sustained a survival rate of 46 percent, while juvenile salmon passing through the turbines experienced a 66 percent survival rate (Hamilton and Andrew, 1954). Studies have not been conducted to quantify the fish guidance efficiency of the facilities. Salmonid fry are not frequently observed at the trap.

Juvenile bypass pipelines exist at both Upper and Lower Baker Developments; however, trap and haul is currently the preferred (and currently necessary) transportation method. Landslides and a spill event at Lower Baker interrupted the connectivity of the bypass pipelines and repairs are difficult due to the location, the topography and the configuration of the canyon through which it transits. Downstream passage facilities were fully operational (i.e., modified barrier nets, attraction barge, fish trap/sampling area, fish transport system) at both Upper and Lower Baker during the 2001 outmigration season.

In addition to fish passage facilities, PSE also operates a spawning beach complex to facilitate the reproduction of sockeye salmon (*O. nerka*) in the Baker River. Surveys conducted by the Washington

Department of Fisheries in the 1950s prior to construction of the Upper Baker Dam identified that most sockeye spawned along southern shore of the original Baker Lake utilizing gravel areas with underground flow. Stream spawning sockeye appeared generally limited to Channel Creek, which contained a strong underground flow similar to the lakeshore environments (Quistorff 1992). Construction of the Upper Baker Development raised the level of the original Baker Lake nearly 60 feet and created a nine-mile long reservoir. The spawning beach complex was designed to replace the original Baker Lake sockeye spawning beds inundated by the Upper Baker reservoir.

Three spawning beaches are located at the northern end of Baker Lake (Figure 1-1). Spawning beaches 1, 2 and 3 are located together at one facility near Channel Creek (Beach 1 is not functional and has not been used since 1965). Beaches 2 and 3 are used intermittently by the Washington Department of Fish and Wildlife (WDFW) to augment production during years of high returns. The water supply for these facilities originates from a spring and surface water collector. Spawning Beach 4, constructed near Sulphur Creek in 1990, replaced Beaches 1, 2 and 3. A spring located on the north side of Sulphur Creek provides water for Beach 4. Fry are allowed to leave Beach 4 on their own volition, directed into a trap and haul facility and trucked to Baker Lake for release.

Baker River sockeye carry the Infectious Haematopoietic Necrosis (IHN) virus. Therefore Beach 4 was divided into four segments to isolate disease outbreaks by segregating the population into smaller groups of fish and preventing water transfer between the sections. Approximately 2.5 cfs is supplied to each beach section (10 cfs total). Fry are tested periodically for IHN at a WDFW laboratory. In the event of an IHN outbreak, effluent from Beach 4 can be diverted through a chlorination/dechlorination system that kills the IHN virus before it enters Sulphur Creek.

3. REGULATORY PROCESS ISSUES

3.1 ACTION AREA

The Baker Project consists of two dams (Lower and Upper Baker Dams), two reservoirs (Lake Shannon and Baker Lake) and limited lands near the dams that are used for Project operational purposes. The Project boundary encompasses approximately 8,100 total acres consisting of 7,200 total acres of reservoir surface area and approximately 910 acres of land. The Action Area for Project operation and maintenance is described as:

- Lower Baker Dam and associated power production facilities
- Lake Shannon up to the ordinary high water mark
- Upper Baker Dam and associated facilities
- Baker Lake up to the ordinary high water mark
- upstream and downstream fish passage facilities
- fish production facilities
- Lower Baker River between Lower Baker Dam and the Skagit River confluence
- the Skagit River within the active floodplain downstream of the confluence of the Baker and Skagit rivers (RM 56.5).

3.2 SPECIES ADDRESSED BY THIS BIOLOGICAL ASSESSMENT

Coho *(O. kisutch)* and sockeye *(O. nerka)* are the dominant salmon stocks in the Baker River system and comprise about 94 percent of total trap return numbers. Chinook, pink *(O. gorbuscha)*, chum *(O. keta)* salmon and steelhead *(O. mykiss)*, together comprise about 6 percent of average trap returns. Resource agencies have assumed that that the majority of adult chinook salmon observed entering the Baker trap did not originate in the Baker River.

This BA is intended to describe an analysis of the effects of the proposed action on marine animals and anadromous fish currently listed, or proposed for listing as threatened under the ESA, and administered by the NMFS. There are no marine animals known to exist in the Project Area. Puget Sound chinook salmon are the only anadromous species currently listed as threatened under the ESA and known to occur in the Project area. Coastal/Puget Sound bull trout *(Salvelinus confluentus)* are listed as threatened under the ESA, are known to occur in the Project area, and may exhibit anadromy as part of their life history variations. Dolly Varden *(S. malma)* also may exhibit anadromy as part of their life history variations and are under consideration for listing due to similarity of appearance to Coastal/Puget Sound bull trout. Both bull trout and Dolly Varden are species that are administered by the USFWS and will be addressed in a separate consultation document.

3.2.1 Chinook Salmon (*Oncorhynchus tshawytscha*)

Chinook salmon are the largest of all Pacific salmon and can weigh over 100 pounds; however, the average weight is closer to 22 pounds. Chinook salmon, the least abundant of the five Pacific salmon species, were historically found from the Ventura River, California to Point Hope, Alaska (Myers et al. 1998). Currently, spawning populations of chinook exist from the San Joaquin River to the Kotzebue Sound, Alaska (Healey 1991). The Puget Sound ESU encompasses chinook populations (both naturally spawning and hatchery populations) from the Elwha River on the Olympic Peninsula to the Nooksack River in North Puget Sound and south to the Nisqually River. However, of the 38 hatchery populations within the ESU (including Skagit (Marblemount) Hatchery populations) only five of the hatchery chinook salmon stocks are protected under the ESA. The listed hatchery stocks are: Kendall Creek; North Fork Stillaguamish; White River; Dungeness River; and Elwha River.

As of the listing in 1998, the 5-year mean natural escapement (1992-1996) for the Puget Sound ESU had been approximately 27,000 spawners; recent total escapement (natural and hatchery fish) has averaged 71,000 chinook (Myers et al. 1998). The Skagit River supports the largest natural run of chinook salmon in the Puget Sound (WDFW et al. 1994; Cramer et al. 1999) comprised of three spring runs (Upper Sauk, Suiattle, and Upper Cascade), two summer runs (Upper Skagit mainstem/tribs and Lower Sauk) and one fall run (Lower Skagit mainstem/tribs). The escapement goal for all summer/fall Skagit chinook stocks is 14,900 spawners per year, and the aggregate escapement goal for Skagit stocks of spring chinook is 3,000 spawners per year. The Skagit River stocks have experienced consistent failure to achieve escapement goals and are classified as overfished under the Magnuson-Stevens Act (PFMC 1997, 1992). The vast majority of these fish spawn in the Skagit River system upstream of the influence of the Baker Project.

The portion of the mainstem Skagit River that is influenced by the Baker Project area contains reproducing runs of fall chinook salmon that are part of the Puget Sound Evolutionarily Significant Unit (ESU) currently listed as threatened (63 Federal Register 11482). Based upon escapement levels, the Lower Skagit run of fall chinook was classified as depressed due to a long-term negative trend (WDFW et al. 1994). Escapement to mainstem habitats during the 5-year period 1974-1978 was estimated at 3,473 declining to 2,329 during the 5-year period 1987-1991. Escapement levels appeared to be lower in odd years than in even years, possibly due in part to incidental catch of chinook in pink salmon fisheries, and possibly due to biennial differences in production. Information on total production, catches and returns per spawner are unavailable.

Historically, the Baker River chinook run made up a small proportion of the total Skagit River chinook run. When the Baker River trap was initially operated (1926-1933), an average of 157 chinook (standard deviation = 244) returned to the trap during 1926-1933. These figures may be complicated by impacts of construction on the Baker Project occurring from 1924-1927. An average of 216 chinook salmon have returned to the Baker River trap from 1926-1998 (standard deviation = 262). An all-time high of 1,453 fish was recorded in 1967, while a low of one chinook occurred in 1955. Since 1990, an average of 343 adult chinook have returned to the Baker River trap each year.

In the past eleven years, an average of 1,303 juvenile chinook salmon have been collected and transported downstream of the Baker Project. Most of the juveniles handled at the Upper and Lower Baker Developments are age-0 chinook (based on length-frequency analysis). Approximately 30 percent of the downstream migrating chinook captured and transported downstream are age-1+ migrants and approximately 1 percent are age-2+ outmigrants.

Current fisheries management of the Baker River system is based on the assumption that if there was an original Baker River chinook stock that was independent of the Skagit River Stocks, it has been extirpated (PSE 2000). The WDFW modified the procedure for handling the Baker River trap beginning in 1995, reducing the transport of chinook into the Baker system. The WDFW decided that adult chinook entering the trap would have higher reproductive potential if they were returned to the Skagit River. In the Puget Sound chinook ESA listing, a particular concern was expressed about early timing ("spring") chinook. The WDFW began introducing spring chinook, with an early adult migration pattern, into the Baker watershed in 1999. The intent of the experimental program is to determine if these chinook (which tend to rear longer in fresh water) are able to take advantage of habitat in and above the reservoirs. Critical habitat was designated for the Puget Sound chinook salmon ESU on February 16, 2000, by NMFS (65 FR 7764) and included the entire Baker Project area. However, as part of a consent decree signed on March 8, 2002 and subsequently approved by the United States District Court for the District of Columbia on April 30, 2002, the critical habitat regulations for salmon and steelhead adopted by the United States on February 16, 2000, were vacated and remanded to NMFS for new rulemaking consistent with all applicable federal laws. As of May 2002, there is no critical habitat designated for Puget Sound chinook salmon.

In February 2002, the NMFS received several petitions to delist ESUs of Pacific salmon that are currently listed as threatened or endangered under the ESA that have hatchery populations within the ESU but excluded by NMFS from ESA protection (67 FR 6215). Pacific salmon ESUs affected by the petitions include the Puget Sound chinook salmon. The NMFS found that the petitioned actions may be warranted in view of a recent U.S. District Court ruling regarding NMFS' prior treatment of hatchery fish in ESA listing determinations. The NMFS is currently revising agency policy regarding the consideration of hatchery fish in ESA status reviews of Pacific salmonids and is expected to issue a new artificial propagation policy by September 2002. When the NMFS status reviews of Pacific salmonid hatchery stocks are complete, the NMFS will consider whether there is a need to delist or otherwise modify the current listing, protective regulations, or ongoing recovery planning efforts (67 FR 6215).

3.3 ACTIVITIES TO BE COVERED BY THE BA

The Baker Project, as licensed and currently operated, involves activities associated with power generation, flood control, fish propagation, fish passage and protection, and measures specifically designed to reduce the effects of Project operations on listed species. This BA addresses that baseline information and PSE's proposed interim conservation measures, developed in consultation with representatives of the Services and FERC, described in Sections 4.4 through 4.7.

3.3.1 Storage and Release of Water for Power Generation and Flood Control

The Lower and Upper Baker Developments are primarily operated for hydropower generation and flood control. Typically higher reservoir conditions during the summer months provide maximum reservoir elevation and surface area for recreational purposes, and maximize hydraulic head for power generation. Stored water can also be used to provide passage and attraction flows for adult salmon returning to the Baker River. Lower reservoir elevations, typically occurring from November through March, create space to store runoff during periods of sustained high runoff or flood flows.

The Skagit River Basin is the largest basin in terms of drainage area in the Puget Sound. Near the confluence of the Baker and Skagit rivers, the Skagit River has a drainage area of 2,737 square miles compared to a Baker River drainage area of 297 square miles. The average annual discharge of the Skagit River near Concrete is 15,070 cfs compared to an average annual discharge of the Baker River at Concrete of 2,657 (i.e., approximately 18 percent). On an average annual basis, Baker Project operations tend to augment mainstem Skagit River flows during the typical low-flow period of August through early October. Gradual drafting of the Baker reservoirs during the fall often results in higher flows in the Lower Baker River and mainstem Skagit River under regulated conditions relative to unregulated conditions (i.e., stream flow that would occur without the influence of the Project). At a minimum, this drafting must achieve Corps flood control storage requirements of the Upper Baker reservoir pool (Baker Lake) below 720.75 feet by November 1 and below 707.8 feet by November 15. The Upper Baker pool elevation must be maintained below 707.8 feet from November 15 until March 1 providing a total of 74,000 acre-feet of reservoir storage. The Lower Baker reservoir pool (Lake Shannon) can be operated in coordination with Baker Lake to provide flood control protection, but there is no formal agreement governing Lake Shannon operations for storage of winter storm runoff. The effects of Skagit River Basin flood control operations, including the using of reservoir storage at the Baker Project for flood control, are being addressed under separate section 7 consultations between the Corps and the Services.

The storage and release of water for power generation and flood control at the Baker Project affects flows in the mainstem Skagit River below the confluence of the Baker River. Flow management associated with load-following operations may cause fluctuations in mainstem Skagit River flows of up to 4,200 cfs over several hours each day. Under existing conditions, flow fluctuations are monitored based on stage changes measured at the Skagit River USGS gage near Concrete (No. 12194000). The Skagit River gage near Concrete is 2.4 miles downstream of the Baker River confluence; water travel time from the Lower Baker Project to the Skagit River gage near Concrete is about 30-minutes, close enough to reflect Baker Project flow fluctuations without appreciable attenuation (see Appendix A, page 7).

The Baker Project is typically operated as a load-following plant with power generated once or twice a day for 4-hour periods. Hourly generation usually occurs during mornings (i.e., 0500 to 0900) and evenings (i.e., 1700 to 2300). These periods of operation vary daily, weekly and seasonally in response to water availability, power demands, and power value (Appendix A, page 6). For instance, electrical power demand is generally higher Monday through Friday and in response, the Project may not operate during the weekend. During periods of high inflow the Lower Baker Plant may be operated for several days or weeks of continuous generation.

During Baker River load-following operations, flows in the Skagit River rise during periods of generation and fall during periods of non-generation. When hourly flows are viewed over a several day period, the "on-off" generation cycle may reflect a series of waves. The amplitude of the wave trough, or the river stage difference between the highest stage reading with generation "on" and the lowest stage reading with generation "off" may be between 0.9-ft and 1.2 ft as measured at the Skagit River at Concrete gage depending on background river flows (Appendix A, page 8). The width of the wave trough or the time between generation cycles may be 4 to 10 hours or more depending on flow availability and power demand (Appendix A, page 9).

Flows in the mainstem Skagit River are also affected by power generation at the Skagit Project operated by SCL. The Skagit Project is typically operated as a load-following power generation plant with the amplitude of Skagit Project downramp events governed by terms of a 1991 Fisheries Settlement Agreement (FERC, 1991). The timing and amplitude of load-following operations at the Skagit Project vary seasonally, with periods of stage changes more than 6-inches per hour more frequent in November and December compared to September and October (Appendix A, page 10).

The Gorge powerhouse, the lowermost Skagit Project facility, is located on the mainstem Skagit at RM 94.2, about 40 miles upstream of the USGS stream gage near Concrete. The effects of flow fluctuations at the Skagit Project continue downstream and are typically observed as river level changes at the USGS gage near Concrete about 6 to 8 hours after the Skagit Project flow change depending on background flow level (Appendix A, page 11). Since the time of day relationship of peak power demands at the Baker and Skagit Projects are similar, the two projects often follow similar load-following regimes. However, due to the distance between the two projects, the effects of the Skagit Project are observed at the Skagit River near Concrete 6 to 8 hours after the effects of Baker Project load-following operations. As a result, while the two projects may be operating under similar load-following regimes, the effects of the projects on river stage in the Skagit River near Concrete can amplify each other (be mutually additive or mutually reductive) or somewhat offset each other. For example, if the Skagit Project reduces flows 6 to 8 hours before Baker Project reduces flows, the effects of the two projects on mainstem Skagit River flows below the Baker River confluence will exceed those anticipated by operation of either project individually. Conversely, the timing of Seattle's evening peaking operations and PSE's morning peaking operations are such that Seattle often tends to power down at about the same time PSE powers up, and the Skagit River at Concrete experiences less stage change than it otherwise would.

Due to the 40-mile travel distance between the Skagit Project and the Skagit River near Concrete gage, the wave exhibited by load-following operations at the Skagit Project attenuates, or flattens as the wave travels downstream. The combination of wave attenuation and operational restrictions associated with the Skagit River Project 1991 Fisheries Settlement Agreement tends to reduce the amplitude of the Skagit Project load-following wave and broadens or increases the width of the wave trough as it passes downstream. These reductions typically do not coincide with flow reductions caused by the Baker Project.

3.3.2 Flow Management for Aquatic Resource Protection

Although there is no formal minimum flow requirement for the Lower Baker River, an 80-cfs flow is continually released below Lower Baker to allow operation of the adult trap-and-haul facility. During periods of peak sockeye adult migration (i.e., late June through July), PSE has typically generated to pass flow for 4 hours beginning at daylight to provide additional attraction for adult fish staging at the confluence of the Baker and Skagit Rivers. The Lower Baker Plant has operated under a voluntary, gradual unit shutdown program since 1978 to help juvenile salmonids avoid stranding. The program limited the average rate of reduction of river flow whenever the total Skagit River flow fell below 18,000 cfs as measured at the USGS gaging station near Concrete. These downramp restrictions were within the limits of the operational characteristics of the Lower Baker power-generating unit and were similar to operational restrictions associated with Seattle City Light's operation of its Skagit Project.

3.3.3 Fish Passage

As described in subsection 2.3, fish passage facilities are located at both Developments. At Lower Baker, a small barrier dam blocks adult fish from continuing upstream and helps guide them into a trapping facility, where they are lifted into a tank truck for transport to different locations depending on the species. At Upper Baker, a surface collector augmented by full-depth barrier nets guide fish to the trap barge, from which they are loaded into a truck for transport and release into the Skagit River. Downstream passage for juveniles is provided in the Lake Shannon forebay by a surface collector barge similar to the Upper Baker facility.

3.3.4 Fish Propagation and Release

In response to declining runs of both sockeye and coho in the mid-1980s, PSE in consultation with the Baker River Fish Committee (a group of Baker Project, resource agency and tribal biologists) implemented supplementation programs for both sockeye and coho salmon. Rearing of sockeye juveniles continues on an intermittent basis with sub-yearling releases into Baker Lake from raceways at Sulphur Creek. Rearing of coho fry at the Sulphur Creek raceways and pond was initiated in 1981 and was expanded to include adult spawning, egg incubation and rearing of progeny of adult coho collected at the Baker River upstream fish trap.

PSE, in cooperation with the WDFW has also conducted a rainbow trout *(O. mykiss)* planting program since 1968. Trout received as fingerlings are reared to a size of 2 to 3 fish per pound and released into Baker Lake and Depression Lake (Figure 1-1) at mid-summer each year to support the recreational fishery.

3.3.5 Routine Operation and Maintenance

In support of power production and flood control, PSE staff performs a variety of routine support and maintenance operations. In addition to operation of the power plants, minor maintenance tasks are performed daily or during each of the plant operator's work shifts. These include maintenance of roads and reservoir shoreline areas, resort and recreational facilities, and other ancillary facilities and buildings. Periodically, seepage through West Pass Dike into Depression Lake is recovered by means of a pump-back station. Water is discharged into a smooth channel leading into Baker Lake at a point adjacent to the dike to allow generation recovery. More extensive maintenance, overhauls and major repairs are performed during outages scheduled around water availability and system demands.

4. EXISTING AND PROPOSED INTERIM CONSERVATION MEASURES

4.1 UPSTREAM FISH PASSAGE OPERATIONS AND CHINOOK HANDLING PROTOCOLS

Pending relicensing (the "Interim Period"), upstream fish passage will continue to be provided at the Lower and Upper Baker Developments consistent with operational protocols as determined by the Baker River Committee. The Baker River Committee is an ad hoc technical group that has been meeting quarterly for the last 15 years to address on-going project operations related to fish issues. Typical meeting participants include representatives of the NMFS, USFWS, U.S. Forest Service, National Park Service, Skagit System Cooperative, PSE, and WDFW. Consistent with recommendations from the Baker River Committee, a new protocol has been accepted by the resource agencies wherein, starting in 2002, adult chinook entering the upstream fish passage trap prior to August 1 will be hauled upstream to Baker Lake and released. These adult releases are part of an on-going experiment to establish a naturally reproducing population of Skagit (Marblemount) Hatchery surplus spring chinook (Suiattle River brood stock origin) into the Upper Baker system. Skagit (Marblemount) Hatchery chinook are within the Puget Sound ESU but are not protected by the ESA under the current listing. Adult chinook entering the trap after August 1 will be transported downstream and released back into the mainstem Skagit River. In coordination with tribal, federal and state natural resource agencies, minor changes in upstream fish passage may also be implemented to accommodate fish passage studies being conducted as part of PSE's relicensing activities. No other interim changes are proposed pending relicensing.

4.2 DOWNSTREAM FISH PASSAGE OPERATIONS

During the Interim period, downstream fish passage will continue to be provided at Lower and Upper Baker developments consistent with operational procedures in place as of fall 2001. In coordination with tribal, federal and state natural resource agencies, minor changes in downstream fish passage facilities will be implemented to accommodate fish passage studies being conducted as part of PSE's licensing activities.

4.3 FISH PROPAGATION AND RELEASE

Current fish propagation activities funded and implemented by PSE are not essential to the protection and recovery of listed salmonid species. PSE proposes to continue coho and sockeye enhancement. These programs are subject to continuous improvement processes, and PSE expects that minor changes may be implemented in the interim period in coordination with tribal, federal and state natural resource agencies. The rainbow trout planting program is under review. It will be terminated if the Services find that the activities jeopardize or interfere with recovery of listed species. However, no changes are proposed at this time.

4.4 SALMON SPAWNING AND INCUBATION FLOW PLAN

Following the analysis and discussions that have occurred to date, PSE, in consultation with representative of the Services and FERC, has developed and now proposes interim conservation measures consisting of reduced generation at specified times during the lower Skagit River chinook spawning period (October 1 through November 15), synchronizing flow releases from the Baker Project with flow releases (and if possible coordinating flow releases) from the Skagit Project, and providing additional "fish-focused" flood protection to chinook salmon redds in the lower Skagit River. The goal of these proposals is to reduce the risk of redd dewatering and redd scour, and to take some risk of each rather than avoid risk of one problem by significantly increasing risk of the other. Which proposal is implemented depends upon whether PSE and SCL can reach an appropriate and equitable arrangement concerning flow coordination.

FLOOD CONTROL

During the late summer and fall of 2000, PSE, in consultation with the resource agencies, drafted the Baker Project in preparation for flood control and major maintenance activities. The effects of an emerging drought were highlighted at the start of the extended Thanksgiving holiday. On November 20, 21 and 22, 2000, PSE had been drawing down its reservoir to meet its maintenance elevation target and SCL had been "peaking" the Skagit Project (powering up the generators to meet high electricity demand, and then powering them down when electricity demand dropped). As a result, the flows in the Skagit River at Concrete, Washington were fluctuating between 9,000 cfs and 7,000 cfs. However, due to the dry conditions, PSE achieved its target early and shut off the lower Baker turbine. Seattle City Light as a matter of routine operation in anticipation of reduced electrical demand over the extended holiday weekend, independently powered down the Skagit Project. Therefore, both the Skagit Project and Lower Baker River Development shut down operations to their respective minimum flows. And, except for a small rain event on Saturday, it remained dry. Flows in the Skagit River at Concrete, Washington, decreased to approximately 5,700 cfs, although they remained above natural flows during the period November 22 through 27, 2000. Nevertheless, exposed redds were observed over the holiday by local fishermen and State agency personnel.

As a result, and during the drought that followed and continued through the winter months of 2001, concern was raised that redds located along the margins of the mainstem Skagit River would be affected by dewatering during the drought conditions. The Services reviewed the drawdown and flow regimes conducted by the Baker and Skagit Projects to evaluate whether the Projects had supplemented flows while chinook were spawning in the mainstem Skagit River. They concluded that higher flows in preparation for the maintenance work might have caused chinook to spawn at slightly higher elevations along the stream margins. Salmon eggs can survive periodic dewatering provided the eggs remain wet enough to support oxygen transfer to the embryos. Eggs that become dewatered may have a low survival rate if the outer egg membranes become dry enough to inhibit oxygen transfer.

The Skagit River supports the largest natural run of chinook salmon in the Puget Sound. The total escapement goal for summer/fall Skagit chinook stocks is 14,900 spawners per year, and the aggregate escapement goal for Skagit stocks of spring chinook is 3,000 spawners per year. The vast majority of these fish spawn in the Skagit River system upstream of the influence of the Baker Project Sound (WDFW et al. 1994). During the fall of 2000, WDFW estimated that 3,262 fall chinook spawned in the Lower Skagit River and 80 percent of these fish were influenced by the combined operations of the Skagit and Baker Projects (Appendix A). A review of chinook spawning and incubation flows by Washington State Department of Fish and Wildlife biologists surmised that during the fall drought of 2000, production from about 16 percent of chinook salmon spawners in the lower Skagit River was lost due to dewatering (Appendix B). However, this estimate was based on visual observations conducted during aerial surveys. Also it would not be possible to isolate or reasonably estimate independent effects of Baker Project operations, Skagit Project operations or low flows due to drought conditions. For instance, during the fall/winter 2000 drought, the lowest 7-day period of inflow to the Baker Project during December was 870 cfs (R. Barnes, PSE records). In comparison, the average daily flow in December is typically 3,206 cfs (Baker River USGS gage at Concrete No. 12193500, period of record 1960 to 2000).

High flow events in the Skagit River also present a risk of decreased chinook egg-to-migrant survival, and the effects of flooding are generally viewed as a major threat to Skagit River chinook incubation (WDFW et al. 1994, USFS 1998). Chinook spawning during low flows in early October before the fall rains begin typically spawn toward the middle of the river channel, thus reducing the risk of subsequent redd dewatering. However, redds constructed near the channel thalweg may be more susceptible to loss associated with high flow events. As river flows naturally rise in late-October in response to increased rainfall, chinook may select spawning locations higher along the channel margins where they are susceptible to redd dewatering, but may be less susceptible to being destroyed by natural processes during subsequent flood events. These multiple strategies tend to spread and hedge environmental risks to the next generation.

Baker Project operations cannot control flooding in the mainstem Skagit River. However, Baker Project operations can reduce Skagit River flood peaks. Moreover, it appears that additional flood control operational protocols specifically aimed at increasing chinook survival to outmigration could provide significant benefits. As shown in Figure 4-1 prepared by WDFW (Seiler et al. 1999), there appears to be a strong relationship (R^2 of 96%) between peak flows during the incubation season and chinook egg to migrant survival. A similar relationship between dewatering and survival of eggs in the Skagit River has not been demonstrated.

The existing flood control agreement between PSE and the Corps of Engineers provides for 74,000 acre-feet of available flood storage starting in mid-November. However, fall rains that produce flooding conditions in the Skagit River area typically start in mid-October. Between 1970 and 2000, there were 13 annual peak flow events between September 1 and November 15, prior to the date initiating Corps flood control, as measured at the USGS Baker River at Concrete (USGS No. 12193500). Thus, increasing the level of flood protection during the early fall may benefit chinook egg-to-migrant survival in the mainstem Skagit River. Although both flooding and dewatering are potential sources of chinook losses, data supporting benefits associated with flood control in the Skagit River are more substantial than the avoidance of dewatering.

In addition to redd dewatering and egg-to-migrant losses associated with peak flood events, there are other potential risks to chinook production, some of which are affected by flow management in the Skagit and Baker River basins. Extreme low flow conditions in the mainstem Skagit River appear to affect the quality of chinook spawning habitat. During the fall of 2001 (during a portion of which, the drought continued to persist), PSE, Skagit System Cooperative and consulting biologists conducted surveys of chinook spawning areas in the Skagit River between the Baker River confluence (RM 56.5) and a boat launch near the town of Hamilton, Washington (RM 40). Intermittent surveys were conducted by jet boat, walking and helicopter between September 23 and November 9, 2001. Based on observations of habitat conditions at flows as low as 3,560 cfs at the USGS gage near Concrete, it appeared that the quality of chinook spawning habitat would be improved as flows increased up to at least 6,000 cfs (P. Hilgert, R2 Resource Consultants, pers. comm.). Based on analyses of flow records at the Skagit River gage near Concrete, chinook redds constructed at flows up to 6,000 cfs would be at little risk of dewatering through the November through March incubation period.

INSERT

Figure 4-1: Egg-to-migrant survival estimates of wild 0+ chinook salmon, by brood year, as observed in outmigrant traps at RM 17 in the Skagit River (Seiler et al. 1999)

4.4.1 Enhanced Flood Control Proposal

In response to concerns regarding Baker Project operations on Puget Sound chinook salmon pending relicensing, PSE analyzed a variety of potential chinook salmon conservation measures in consultation with the Services and FERC representatives. The data show that high flows in the Skagit River are associated with reduced egg to migrant survival at flows lower than those that are likely to overtop dikes and levies and threaten people and property downstream. One option to increase the level of chinook protection would be to increase the volume of flood control storage so that some could be "fish" rather than "people and property" focused, and begin providing flood control storage on October 1, before the Corps' "people and property" flood control is required, but when big flow events that could affect spawning or redds become more likely. For this reason, PSE proposes providing a total of 115,000 acre-feet of reservoir storage for flood control starting October 1 and maintain that level of flood storage through the end of December.[1] From January 1 through March 1, PSE would maintain flood control consistent with the existing Corps flood control plan. Providing 115,000 acre-feet of flood control by October 1 will reduce the frequency and magnitude of flood events during the chinook spawning period and will reduce the overall peak flood event in the lower mainstem Skagit River by about 8,100 cfs. Assuming an egg-to-migrant survival relationship as described by Seiler et al. (1999) (Figure 4-1), reducing the peak flood event in the lower mainstem Skagit River could increase survival of wild 0+ chinook salmon by 0.8 percent. Assuming a total egg-to-migrant survival of 12 percent, increasing survival by nearly a percent corresponds to a 6.7 percent increase in the total estimate of wild chinook fry survival (0.8 is 6.7% of 12.0). In the most extreme flood events, reducing the flood peak flow by 8,100 cfs could dramatically increase chinook egg-to-migrant survival. In order to provide flood storage of 115,000 acre-feet by October 1, PSE would begin to evacuate the Baker Project reservoirs during the late summer and would use both Baker Lake and Lake Shannon to meet flood control requirements. Based on new data, this timing appears to allow flood control drawdown to precede the period of chinook spawning activity in the lower Skagit River. This operation would not affect PSE's existing flood control agreement with the Corps; that is, PSE could still abide by the terms of that agreement.

Although providing flood storage between October 1 and November 15 and increasing the level of flood control from mid-November through December increases the level of chinook protection, other measures were also considered. One measure that appeared promising consists of a flow management program coordinating Baker Project operations with SCL's operation of the upstream Skagit Project (FERC No. 553) during the lower Skagit River chinook spawning season. Flow in the mainstem Skagit River below the Baker River confluence is affected by operation of the Baker and Skagit Projects, natural flow events that exceed the operational control of the projects, and river flows contributed by tributary systems including the Sauk and Suiattle River Basins. On average, the Baker River provides (and the Baker River Developments somewhat controls) only about 18 percent of the total flow measured in the mainstem Skagit River near Concrete. However, as indicated by the flood control measure, Baker Project operations can have a greater influence on mainstem Skagit River habitats than indicated based on drainage area alone. Coordinating management of flows between the Baker and Skagit Projects is an opportunity to extend the influence of the Baker Project beyond its relative flow contribution based on drainage area.

4.4.2 Coordinated Flow Management Plan

In addition to Enhanced Flood Control, flow coordination will reduce the amplitude of flow fluctuations in the mainstem Skagit River immediately below the Baker River confluence during the chinook spawning season by intentionally generating power at the Lower Baker Development to fill the wave

[1] Flood control operations are subject to storage directives later in the discussion.

“troughs” created by load-following operations of the upstream Skagit Project. The effect of filling the wave troughs depends on the amplitude and width (or duration) of the Skagit Project load-following wave. To efficiently operate the Baker Project during this Interim period utilizing this method of enhancement, this measure would benefit from close coordination between PSE and Seattle City Light to predict and manage the amplitude and duration of the Skagit Project wave troughs. Several flow management options were developed because it was not possible to predict, going forward in time, either the magnitude or duration of the Skagit Project load-following wave troughs. However the general pattern was estimated from historic records from the USGS gage at Newhalem (USGS Gage No. 12178000), and then compared with Baker Project equipment constraints. These data were then utilized to formulate options to release water from the Baker Project into the Skagit Project wave troughs.

Volumetric Displacements: Under this option, PSE will generate power at the Lower Baker Project during the lower Skagit chinook spawning season to fill the volume of the Skagit Project wave trough. The volume of the wave trough would be calculated at Newhalem (USGS Gage No. 12178000) and flow of equivalent volume would be released through generation at the Lower Baker Development at the approximately the time the trough passes the Baker River confluence. Instantaneous stage might be greater than the peak to trough delta but, to the extent possible, the volume of the water released from Lower Baker would not, except as described in the "Fall Flood Storage Directive" and "Generation Directive during lower Skagit River Chinook Spawning Season" exceed the volume of the trough.

Under this volumetric displacement scenario, the 115,000 acre-feet of flood storage is predicated on the volume of water that can be discharged to fill the wave troughs created by Skagit Project load-following operations. The volume of water to be released by generation at the Lower Baker Development is determined by the amplitude and width (duration) of the trough. For example, assuming Skagit Project peak to trough delta of 3,800 cfs, and assuming a total trough duration of 16 hours (8 hours at 3,800 cfs), Baker Project operations could maintain the desired 115,000 acre-feet of flood control without overfilling the Skagit Project load-following troughs on an 80 percent reliability. The reliability drops markedly if the flow delta from Skagit Project amplitude (peak to trough) is only 2,000 cfs, or the duration of a Skagit Project load-following event is less than 16 hours.

Amplitude Limitation: This option is not possible given the current Baker Project equipment (which has a minimum operating discharge of 3,200 cfs) unless SCL generates a trough equal to the minimum generation requirement at lower Baker for a period of sufficient duration to permit generation. For example, if the amplitude of the Skagit Project load-following trough were approximately 3,800 cfs for 16 hours each day, given attenuation of the trough downstream, then approximately 135,000 acre-feet of storage would be required to provide a 75 percent reliability. Again, if the amplitude of flow differential were only 2,000 cfs, then PSE could not generate into the Skagit Project "trough" without at least temporarily increasing flow in the Skagit River.

In considering the relative effects and benefits of generating (and maintaining flood control storage) and ceasing generation (keeping lower mainstem Skagit River stage lower and encouraging lower spawning less susceptible to future dewatering risk), the Services encouraged PSE to enter into discussions with Seattle City Light to determine if the amplitude of the Skagit Project load-following trough could be increased, thereby allowing Puget to fill a larger trough without "overfilling" the Skagit Project trough. If an appropriate and equitable coordination agreement can be reached between PSE and SCL, then PSE would implement the agreement and generate power at the Lower Baker Development at a flow that would not exceed the amplitude of the trough created by the Skagit Project at Newhalem (USGS Gage No. 12178000). The Services representatives suggested that PSE contact Seattle City Light to pursue this option with agency and FERC support, providing that any change to Skagit Project operations must be consistent with the 1991 Fisheries Settlement Agreement.

If Seattle City Light agrees to implement load-following operations that create sufficiently large troughs, the proposal is for PSE to create 115,000 acre-feet of flood storage at the Baker Project by October 1 with a number of operational directives:

Fall Flood Storage Directives:

The Baker and Skagit River basins experience significant precipitation and flood control is an important issue for people, property and fish, all of which are considered in the following:

1) This conservation measure will not affect the existing PSE/Corps of Engineers flood control agreement.

2) PSE will create 115,000 acre-feet of flood storage capacity at the Baker Project by October 1.

3) PSE will maintain a flood storage capacity *target* of 115,000 acre-feet during the period October 1 though December 31; but will maintain at least 95,000 acre-feet of available flood storage during this period unless PSE loses control of the Baker Project or the Corps directs otherwise. If the generation directives (below) are unable to maintain 115,000 acre-feet of storage capacity and inflow to the Project reduces available storage capacity to less than 95,000 acre-feet, PSE will generate continuously to restore 115,000 acre-feet of available flood storage capacity or December 31 is reached, whichever is sooner.

4) During the period October 1 through November 15, available flood storage capacity will not, by virtue of fisheries operations, exceed 156,000 acre-feet (i.e., PSE will reserve up to 41,000 acre-feet of reservoir storage as a hedge against dry conditions).

5) If the Skagit River flow measured at the USGS gage near Concrete is greater than 40,000 cfs, and Baker Project storage capacity exceeds 74,000 acre-feet, PSE will consult with the Corps of Engineers regarding the timing of Baker flow releases to reduce peak flows. If the flood peak can be significantly reduced, PSE will shutoff all generation and store inflow until the flood crest estimated by the Corps passes or until 74,000 acre-feet of storage capacity is reached, whichever is sooner. If reservoir storage capacity reaches 74,000 acre-feet between November 15 and March 1, regulation of storage capacity will be governed by the PSE/Corps of Engineers flood control agreement.

Generation Directives During Lower Skagit River Chinook Spawning Season:

During the period October 1 through November 15

1) PSE will try to generate into Skagit Project load-following troughs by generating power at the Lower Baker Development that *targets* releasing flows of an "average" amplitude no greater than the depth of the Skagit Project load-following trough as observed at the Newhalem (USGS Gage No. 12178000). The intent is to stabilize middle Skagit River flows by generating into, but not overfilling the Skagit Project load-following troughs. The conferees recognized and accept that as the Skagit Project ramps down and the Baker Project turns on, and again as the Baker Project ramps down and the Skagit Project turns on, bi-modal magnitude exceedances will likely occur for short periods. However, given information concerning the amount of time it takes for redd establishment to occur, these temporary exceedances are not viewed as significant.

2) A “trough” is defined as the peak-to-peak (duration) and peak-to-trough (amplitude) over a period of no more than 60-hour duration (i.e., Friday night to Monday morning) as measured at Newhalem (USGS Gage No. 12178000).

3) If PSE cannot meet the Amplitude Limitation without violating storage directives, PSE will still try to work within the Volumetric Displacement approach to power generation; that is, PSE will release no more water than the volume of the Skagit Project load-following troughs (subject to high flow conditions outlined below).

4) If Skagit River flows near Concrete are greater than 20,000 cfs (but subject to modification if flows exceed 40,000 cfs as described above), PSE has the option to generate constantly at the Lower Baker Development, and would plan to do so until 115,000 acre-feet of available flood storage is restored.

5) When Baker inflow is less than the 85 percent exceedance value (i.e., low flow conditions), PSE will generate into Skagit Project load-following troughs (without regard to magnitude) or, if and during any extended period the Skagit Project operates at its minimum flow, PSE will generate up to 3,200 cfs continuously at the Lower Baker Development, not to exceed 156,000 acre-feet of total evacuated storage.

6) If Baker inflow is greater than the 15 percent exceedance value (i.e., high flow conditions), PSE will initially generate to fill Skagit Project load-following troughs or generate continuously at the Lower Baker Development if needed to maintain 115,000 acre-feet of total flood storage.

In the event that this combined Enhanced Flood Control / Coordinated Flow Management Plan is not achievable because an adequate and equitable coordinated flow agreement between PSE and Seattle City Light can not be developed, an alternative combined Enhanced Flood Control / Split Spawning Season Flow Management Plan will be implemented.

4.4.3 Split Spawning Season Flow Management Plan

Chinook salmon redds constructed during extreme low flow conditions are typically located near the center of the mainstem Skagit River channel where they are at little risk of being dewatered during the ensuing winter incubation period. To increase the likelihood that chinook salmon would construct redds where there is less risk of dewatering, the Baker Project could reduce flow to the mainstem Skagit River by storing inflow. Even if such an approach were otherwise reasonable, the Baker Project cannot reliably cease generation during the chinook spawning season because the project reservoirs are simply too small. Assuming a chinook spawning period of October 1 through November 15, even if both the Baker Project reservoirs were at minimum pool on October 1, and all active storage in both reservoirs (307,000 acre-feet) were available, the Baker Project would still be unable to store all inflow approximately 1 out of 5 years. In addition, while reducing flow to the mainstem Skagit River during the chinook spawning period would reduce the risk of redd dewatering, it might increase the risk of egg-to-migrant losses associated with peak flow events, if they occurred when the reservoirs were full. Finally, if the reservoirs were drawn down and another drought occurred as happened last year, there could be little or no water left in the reservoirs for winter power generation or mainstem Skagit River flow maintenance.

The "Split Spawning Season Flow Management Plan" is designed to balance risks of chinook egg losses associated with dewatering and risks of egg-to-migrant losses associated with peak flood flows. The Pacific Northwest typically has dry periods of low rainfall through middle October followed by increasing chances of heavy rainfall. An analysis of long-term precipitation records collected at Concrete, Upper Baker Dam and Newhalem, Washington indicated that approximately midway through the October 1 through November 15 period, there is a pronounced increase in the chance of more than 1-inch of total rainfall in a 7-day period (see Appendix C containing analyses conducted by Laprade and Grant [1991]). Fall chinook that spawn in the mainstem Skagit River below the Sauk River confluence (RM 66) are considered to be October spawners (WDFW et al. 1994). Based on spawning surveys conducted during the fall of 2001, chinook spawning in the mainstem Skagit River below the Baker River confluence extends from late September or early October through mid-November. The weighted mean spawning date for chinook in Lower Skagit River index survey areas is mid-October, 18 days later than the weighted mean spawning date for Upper Skagit River index survey areas (Currens et al. 2002). Maintaining relatively low flows in the mainstem Skagit River through the first half, or “dry” portion of the chinook spawning period provides a measure of redd protection from potential dewatering during low incubation flows. Allowing chinook to spawn higher along the stream margins during the later, “wet” half of the spawning period may provide a measure of redd protection from potential flood flows during winter storm events. Splitting the period to correspond with the typical changes in normal precipitation patterns seemed logical.

Again, this conservation measure will be implemented subject to and so as not to affect the existing PSE/Corps of Engineers flood control agreement. It combines elements of enhanced flood protection during the spawning and incubation period with flow management to allow chinook salmon to spawn under a range of hydraulic conditions. To create storage prior to lower Skagit River chinook spawning and consistent with the Enhanced Flood Protection objective, PSE will create 115,000 acre-feet of flood storage at the Baker Project by October 1. During the period October 1 through November 15, available flood storage will not exceed 156,000 acre-feet (i.e., PSE will reserve up to 41,000 acre-feet of reservoir storage as a hedge against dry conditions). If the Skagit River flow measured at the USGS gage near Concrete is greater than 40,000 cfs during this period, and Baker Project storage exceeds 74,000 acre-feet, PSE will consult with the Corps of Engineers regarding the timing of flow releases to reduce peak flow. If the flood peak can be significantly reduced, PSE will shutoff all generation and store inflow until the flood crest estimated by the Corps passes. However, since under this proposal, PSE will ultimately release less water during the Lower Skagit River chinook spawning season (which will reduce available storage at that time), there is somewhat less likelihood that the "fish-focused" flood control will be available.

<u>Early Chinook Spawning Period, Oct 1 to 21</u>

1) During the majority of the 21–day early spawning period, PSE will store inflow to the Baker Project and avoid generation at the Lower Baker Development; that is, during Baker River inflow of 550 to 2,500 cfs (70% frequency), the Baker River flow contribution to the Skagit River will be 80 cfs.

2) During periods of low inflow (less than 550 cfs, 85% exceedance value), PSE will generate at least 3,200 cfs at the Lower Baker Development into Skagit Project load-following troughs or will generate at 3,200 cfs on a continuous basis not to exceed 156,000 acre-feet of evacuated reservoir storage. Thus, when Baker River inflow is unusually low, the flow contribution of the Baker River to the Skagit River will augment natural inflow. Generating power at the Lower Baker Development during periods of low Baker River inflow will support the maintenance of Skagit River flows near Concrete above 6,000 cfs.

3) During periods of high Baker River inflow (greater than 2,500 cfs, 15% exceedance value), PSE will generate power at the Lower Baker Development to restore available flood storage. PSE will initially generate to fill Skagit Project load-following troughs or generate continuously at the Lower Baker Development if needed to maintain 115,000 acre-feet of total flood storage. The patterns of precipitation at Newhalem, Concrete and Upper Baker Dam are relatively similar (see Appendix C), thus periods of high Baker River inflow typically coincide with periods of high inflow from other Skagit River tributaries.

<u>Late Chinook Spawning Period, October 21 to November 15</u>

1) During the majority of the 24-day late spawning period, PSE will generate power at the Lower Baker Development to restore available flood storage. During the majority of the October 1 to 21 period, inflow to the Baker Project would have been stored which reduces available flood storage capacity. In view of the increased likelihood of fall rains after October 20, power would need to be generated at the Lower Baker Development to evacuate flood storage. Depending on the level of available flood storage on October 21, PSE will initially generate into Skagit Project load-following troughs or generate continuously at the Lower Baker Development if needed to restore available flood storage. If available flood storage capacity on October 21 is less than 74,000 acre-feet, PSE will generate continuously to restore flood storage capacity to that level. If the available flood storage capacity is

greater than 74,000 acre-feet but less than the target level of 115,000 acre-feet, PSE will evacuate storage through generation at a rate needed to achieve the target storage level by November 15. Flows will preferentially be released during the Skagit Project troughs prior to releasing flows outside of these time periods.

2) During periods of low inflow to the Baker Project (750 cfs, 85% exceedance value), PSE will generate at least 3,200 cfs at the Lower Baker Development into Skagit Project load-following troughs or will generate at 3,200 cfs on a continuous basis not to exceed 156,000 acre-feet of evacuated reservoir storage. When Baker River inflow is unusually low, the flow contribution of the Baker River to the Skagit River will augment natural inflow.

3) During periods of high Baker River inflow (greater than 3,400 cfs, 15% exceedance value), PSE will generate power at the Lower Baker River Development to restore available flood storage. PSE will initially generate into Skagit Project load-following troughs or generate continuously at the Lower Baker Development if needed to maintain 115,000 acre-feet of total flood storage.

The Split Spawning Season Flow Management Plan was designed to complement natural precipitation patterns. Storing Baker River inflow in early October will keep redds lower in the river channel to address dewatering risks. During a fall/winter drought, as was experienced in 2001, the Split Spawning Season Flow Management Plan would have increased the level of protection for early spawning chinook. Storing inflow during early October will reduce available flood storage capacity and reduce the level of flood protection. During the last three weeks of the chinook spawning season, power generation at the Lower Baker Development will gradually restore available flood storage capacity while allowing chinook redds to be broadly distributed across the Skagit River channel. If a peak flood event occurs during late October before flood storage capacity can be fully restored, this split season approach will provide increased flood protection compared to existing conditions but will not provide as much flood protection as the Enhanced Flood Control / Coordinated Flow Management program.

<u>Summary</u>

Both the Enhanced Flood Control / Coordinated Flow Management Plan and the Split Spawning Season Flow Management Plan increase the level of chinook protection by augmenting flows during extreme low flow conditions during the chinook spawning season, enhancing flood protection during the chinook spawning and incubation period, and reducing daily flow fluctuations in the middle mainstem Skagit River during the chinook spawning period. Due to the ability to maintain a larger flood storage capacity, the Enhanced Flood Control / Coordinated Flow Management Plan is able to provide greater flood protection to reduce the impacts of peak flood events on egg-to-migrant survival than the split season approach to flow management.

4.5 DOWNRAMP RATE

Under current operations, water in the lower Baker River passes through the single power-generating unit at Lower Baker Dam, through a 24-inch bypass pipe (80 cfs), leakage through pressure relief holes in dam abutments, or is spilled through the Lower Baker Dam over the spillway crest at elevation 425-feet. When Lower Baker Unit 3 ceases generation, an 80-cfs flow is continually released below Lower Baker through the 24-inch bypass valve to allow operation of the adult trap-and-haul facility. During periods of peak sockeye adult migration (i.e., late June through July), PSE has typically generated for 4 hours beginning at daylight into the Lower Baker River to provide additional attraction for adult fish staging at the confluence of the Baker and Skagit Rivers.

The Lower Baker Plant has operated under a voluntary, gradual unit shutdown program since 1978 to help juvenile salmonids avoid stranding. Under the program, PSE limits the average rate of reduction of river flow whenever the total Skagit River flow falls below 18,000 cfs (measured at the Skagit River USGS gage near Concrete, No. 12194000). The purpose of the protocol is to reduce rapid flow reductions in the mainstem Skagit River immediately below the confluence of the Baker River. Figure 4-2 shows PSE's current downramping profile, which is consistent with the capabilities of the single generating unit at the Lower Baker Plant. The recently refurbished Lower Baker generating unit develops severe vibrations when running at less than about 75 percent capacity. To achieve the downramping protocol, PSE needs to hold the unit for a one-hour period in the cavitation zone. This activity will continue to be evaluated. When Skagit River flows are greater than 18,000 cfs at the USGS gage near Concrete, there will be no downramp restrictions on PSE’s operation of the Lower Baker Development.

4.6 RESEARCH AND MONITORING ACTIVITIES

PSE plans to file an application to relicense the Baker Project on or before April 30, 2004. In advance of that filing, PSE (as the prospective license applicant) began working with tribal, federal, state, and local agencies, non-governmental organizations and private parties to identify studies and monitoring efforts necessary to support an application to relicense the project. A Hydrology and Aquatic Resource Working Group (HARWG) was formed to develop and review flow, fish and aquatic habitat related study requests and study plans. Any working group member can prepare and submit a study request that provides the working group with information necessary to evaluate and prioritize study efforts. Once the working group approves the study concept, an in-depth proposal and budget is prepared and distributed to the working group for review. Final approval and funding of the study is decided based on methods described in the Baker River Project Process Document [www.pse.com/hydro/baker/].

A total of 35 study requests have been submitted to the Hydrology and Aquatic Resources Working Group as of February 2002. Several of the study requests were approved in 2001 and field measurement efforts and data analyses are underway. Approval of other study requests is still pending; and some study requests and resultant studies may not proceed. A brief description of the objective of various study requests and current status is described in Appendix D. Information developed during relicensing will examine the effects of project operations on listed and non-listed species and their habitats and are anticipated to be used to identify and develop other conservation measures for their long-term protection.

In addition to research measures described in Appendix D, monitoring and reporting of flow management measures will be implemented during the Interim licensing period. Real-time monitoring of flows at the Baker River USGS gage at Concrete, Washington (No. 12193500) is currently available at the USGS

Internet web site [wa.water.usgs.gov/realtime/frames_view.html]. The USGS Internet site provides a running 7-day record of hourly flow fluctuations below the Lower Baker Project that clearly identifies the effects of project operations. Every 6 months PSE will submit a report to the NMFS and the FERC identifying and describing any instances of project operations that deviate from the proposed conservation measures.

INSERT

Figure 4-2: Downramping protocol for the Baker River Project as measured at the Baker River at Concrete (USGS gage 12193500)

4.7 EMERGENCY EXCLUSION

Flood control measures required to protect human life and property will override requested releases for fisheries benefits. In the event of an emergency power shortage, all available water stored behind the Baker Project reservoirs may be used to generate power.

5. ENVIRONMENTAL ANALYSES

5.1 INSTREAM CONDITIONS

5.1.1 Spawning and Incubation

The Skagit River Basin supports stocks of Upper Sauk, Suiattle, and Upper Cascade spring chinook salmon. These stocks spawn in tributaries to the Upper Skagit River and pass through the Lower Skagit River during their upstream migration. The lower Skagit River below the Baker River confluence supports a naturally reproducing population of fall chinook salmon. Fall chinook salmon typically have a short freshwater residence period, therefore spawning, incubation and early rearing habitat are key factors affecting production. Spawning and incubation habitat is generally defined by flow and substrate conditions. Chinook spawning habitats potentially affected by continued operation of the Baker Project are found in the Upper Baker watershed, the Lower Baker River, and the mainstem Skagit River below the Baker River confluence.

Current fisheries management of the Upper Baker watershed is based on the assumption that if there was an original Baker River chinook stock, independent of mainstream Skagit stocks, it has been extirpated. Starting in 2002, and consistent with protocols developed by the Baker River Committee, only adult chinook that enter the Baker trap before August 1 are transported and released into Baker Lake. These adult releases are part of an on-going experiment to establish a naturally reproducing population of Skagit (Marblemount) Hatchery surplus spring chinook (Suiattle River brood stock origin) into the Upper Baker system. Chinook have not been observed spawning in the fluctuation zone of the Upper Baker reservoir, and drawdown of the Upper Baker reservoir above the Corps flood agreement level has not been identified as creating barriers to fish movement (USACE 2000).

Adult chinook salmon entering the lower Baker River have access to approximately 2,600 linear feet of low gradient Baker River habitat below the barrier weir leading to the fish trap. This short reach of river was dredged during the 1950s (HRA 2000) and is inundated by backwater from the mainstem Skagit River when the Lower Baker Development ceases generation. The Lower Baker Dam and reservoir limits gravel recruitment in this reach to small events downstream of the Lower Baker Dam. Chinook use of this reach is primarily for adult holding and transportation. As part of relicensing activities, several studies will evaluate potential habitat improvement opportunities in this reach (see Study Requests A-2 Lower Baker River Habitat Mapping, A-16 Lower Baker Alluvial Fan/Channelization, A-20 Large woody Debris Management and A-24 Hydrologic and Geomorphic Analyses in Appendix D).

As discussed in section 3.2.1, the mainstem Skagit River below the confluence of the Baker River supports reproducing runs of fall chinook salmon. The weighted mean spawning date for fall chinook in this reach is mid-October and incubation continues through March and April. Under existing conditions, spawning flows in the Skagit River are generally elevated by PSE's evacuation of the Baker Project reservoirs to provide flood control as part of the Corps' flood control management (see section 3.3.1).

These releases may allow chinook to spawn higher on the channel margins where their eggs may be more susceptible to dewatering should a winter drought dramatically reduce flows in the Skagit Basin. In addition to the potential effects of higher average flows during the chinook-spawning period, load-following operations may affect salmon spawning by causing them to expend energy responding to fluctuating flows. Under existing conditions, load-following operations at the Lower Baker Development typically cause flows in the mainstem Skagit River to fluctuate up to 3,800 cfs on a daily basis. Once female chinook salmon establish a redd, they may move off the redd when the flow drops and move back and complete the spawning act during higher flows. It is possible that this could occur during flow fluctuations associated with Lower Baker power generation.

The proposed interim conservation measures will increase the existing level of chinook protection by augmenting flows during extreme low flow periods, reducing the magnitude of peak flood events during the period of greatest flood risk and reducing flow fluctuations in the lower mainstem Skagit River during spawning periods (see section 4.4). In general, stream flow regulates the quantity of spawning habitat available. As flows increase, more gravel is covered and suitable spawning habitat increases. However, increased flows may not be beneficial if the redds are subsequently dewatered during the incubation period, or if velocities exceed those acceptable to specific species. Augmenting flows from the Lower Baker Development during periods of low Baker inflows will increase the amount of available spawning habitat, but should maintain flows low enough that the eggs remain wetted through periods of low winter flow. The proposed action increases the potential salmon benefits of flood control by both increasing the storage goal above the level provided by the agreement between PSE and the Corps of Engineers and by developing that storage earlier in the flooding season. These changes can reduce annual mainstem Skagit River flood peaks and thereby potentially increase survival to outmigration. Seasonal flooding can limit chinook production by inducing mortality during the embryo incubation life phase by deposition of silt (reducing percolation rates and egg hatching success) and scouring the streambed and disrupting incubating embryos.

The proposed action will also benefit chinook by reducing flow fluctuations in the Skagit River during the spawning period. The proposed action includes scheduling of the project operations to coincide with the timing of the "trough" associated with the operation of the upstream Skagit Project. This will reduce the flow fluctuations in the river that might affect the success of spawning. The proposed conservation measure should reduce the risk of redd dewatering that was identified as a concern during the winter of 2001. It should also help improve the overall success of chinook spawning and incubation in the Lower Skagit River. Should the combined Enhanced Flood Control / Coordinated Flow Management Plan not be achievable because an adequate and equitable coordinated flow agreement between PSE and Seattle City Light can not be developed, the alternative combined Enhanced Flood Control / Split Spawning Season Flow Management Plan will be implemented. That alternative should also help improve the overall success of chinook spawning and incubation in the Lower Skagit River relative to baseline conditions.

5.1.2 Early Juvenile Rearing

The survival of developing eggs is primarily dependent on the interactions of water temperature, dissolved oxygen, water velocity, gravel permeability and stock genetics. Following spawning, the duration of the embryo incubation period can be estimated by tracking water temperatures within the redd environment. An accounting of accumulated temperature units provides an index of the duration of incubation. Laboratory studies have indicated that chinook eggs require 882 to 991 temperature units on average before hatching (1 temperature unit = 1 degree C above freezing for 24 hours) (Beauchamp et al. 1983). The young chinook, termed alevins, remain in the gravels for 2 to 3 weeks after hatching (Wydoski and Whitney 1979). Researchers tracking chinook egg development in Upper Skagit River habitats observed that chinook begin to emerge from the intragravel environment as early as January, peaking in March, and extending as late as April (Graybill et al. 1979).

Many variations in juvenile life history are possible within runs of fall chinook salmon (Healey 1991) including five different juvenile chinook salmon life history strategies as described by Reimers (1973):

- emergent fry move directly downstream and into the ocean within a few weeks;
- juveniles rear in mainstem margin or off-channel habitats until early summer, emigrating downstream into the estuary for a short rearing period before entering the ocean;
- juveniles rear in mainstem margin or off-channel habitats until early summer, then emigrate into the estuary for an extended rearing period before entering the ocean in autumn;
- juveniles rear in tributaries, mainstem margin or off-channel habitats until autumn rainfall begins, then emigrate to the ocean; and
- juveniles remain in tributary streams, in mainstem margin or off-channel habitats, through the summer, rear in the river until the following spring, and enter the ocean as yearlings.

The proportion of juvenile chinook in the mainstem Skagit River exhibiting the variations in freshwater residence described above could be dictated by both genetic and environmental factors. Environmental cues such as temperature increases, streamflow, reduced food supply and changes in photo-period are all factors that lead to the evolution and expression of particular juvenile outmigration timing (Myers et al. 1998).

During the early juvenile rearing lifestage, chinook fry are affected by flow modifications associated with operation of the Baker Project in several ways. Prior to hatching, salmon eggs can withstand short-term periods of dewatering. Salmon that have hatched but remain within the interstices of the gravel (i.e., alevins) are especially susceptible to injury should falling river levels cause them to become dewatered for even one hour (Becker et al. 1983, 1982). The average monthly flow in the mainstem Skagit River near Concrete in March is over 12,000 cfs. However, extended periods of cool, dry weather during March can reduce runoff in the Skagit basin causing river flows to drop. Operation of the Skagit and Baker River Projects can exacerbate low flows in the mainstem Skagit River when the Projects reduce or cease generation during load-following operations.

After emergence, some of the lower Skagit River chinook fry move downstream while others typically rear in the river for 30 to 90 days prior to migrating downstream. Chinook fry remaining within freshwater habitats during this early rearing life history phase feed on juvenile and adult aquatic insects. Studies of the food habits of salmonid fry in the Upper Skagit and Sauk rivers found that juvenile chironomid larvae were the most abundant food item in the stomach contents of early chinook fry (Graybill et al. 1979). Frequent flow fluctuations associated with load-following operations of the Baker and Skagit Projects can temporarily dewater portions of the channel margins which reduces benthic productivity (e.g., the abundance of chironomid larvae) in the varial zone which affects the food sources of rearing salmonids (Graybill et al. 1979, Gislason 1985). Identifying the effects of Baker Project load-following operations is complicated by the influence of non-project related factors occurring upstream of the Baker River confluence but extending downstream into reaches affected by the Baker Project. These downstream influences may include but not be limited to: daily and hourly flow fluctuations associated with natural runoff from glacial and non-glacial upstream tributaries and the downstream influence of the Skagit Project. The varial zone associated with natural flow fluctuations from upstream tributaries and the Skagit River Project may overlap the Baker Project varial zone masking direct project effects.

In addition to expending energy searching for aquatic insects, rearing salmonids may also expend energy as they respond to flow changes associated with load-following operations. Both the quantity and location of suitable fry habitats change as river flows change. As a result of flow fluctuations, the potential daily movement of fry between habitats diverts energy resources that might otherwise go into growth and conditioning (Brett 1995).

During this period of early juvenile rearing, chinook fry seek low velocity microhabitats within the coarse streambed structure or slow water habitats associated with stream margins or backwater areas. Reservoir refill during this period (see section 5.1.3) may benefit chinook fry habitat by increasing the availability of low velocity areas. Springtime refill of the Baker reservoirs during recent years reduced flows in the mainstem Skagit River an average of 4.3 percent. Although load-following operations may affect the availability of chinook fry habitats on a daily basis, springtime reservoir refill may provide some unquantified increase in the availability of low velocity habitats on a seasonal basis. As part of the FERC relicensing studies, electrofishing surveys are being considered to help identify the timing of downstream movements of the juvenile salmonids and provide a check on information gathered at the downstream screw trap operated by the Washington Department of Fish and Wildlife (see Appendix D, Study Request A-9d Distribution and timing of salmonid fry in the middle Skagit River). These efforts are designed to confirm the timing of fry emergence and the early growth of juvenile salmonids to help identify flow management measures to protect this early life history phase.

5.1.3 Instream Juvenile Migration

While some chinook fry move quickly downstream to rear in the estuarine environment, other fry may rear in mainstem margin and off-channel areas for several months or up to a year or more before moving seaward. Chinook salmon have evolved rather diverse juvenile life history strategies and their prolonged outmigration strategy may reduce the probability that a single negative event will affect all life history types. This strategy likely evolved to enhance the long-term stability of stocks in a variable environment (Pearcy 1992). Downstream migrating chinook fry are affected by natural flow variations associated with unregulated tributary runoff and changes in flow associated with Skagit and Baker Project operations.

Lower Skagit River fall chinook may begin migrating downstream immediately, or within 30 to 90 days following emergence. Emergence may occur as early as January, but based on studies conducted in Upper Skagit River reaches, peak chinook emergence occurs in March, with downstream migration occurring through June (Graybill et al. 1979, Stober et al. 1982). The existing FERC license conditions and the flood control agreement between PSE and the Corps of Engineers requires that 74,000 acre-feet of available flood storage capacity be maintained through March 1. Following the flood control season, PSE begins to refill the Baker reservoirs and attempts to reach full pool by the end of May. Thus, during much of the chinook downstream migration period, refilling of the Baker Project reservoirs reduces flow in the Lower Baker and mainstem Skagit River. Since 1992, and excluding years where operations were modified to accommodate major maintenance and repairs, refill of the Baker reservoirs between March 1 and May 31 stored an average of 25 percent of the inflow to the reservoirs. Releases from the Lower Baker Development during the springtime reservoir refill reduced average daily flows to the mainstem Skagit River by 643 cfs. During the springtime period in those same years, flows in the mainstem Skagit River near Concrete averaged 14,823 cfs; thus, spring refill of the Baker reservoirs reduced flow in the mainstem Skagit River by an average of 4.3 percent.

The rate of downstream migration of juvenile chinook may be affected by a variety of factors including flow, food supply, channel morphology, temperature, daylength, turbidity, lunar cycles, diurnal period, concomitant hatchery releases, degree of smoltification (as indicated by ATPase levels), and migrant size (USACE 1998). The ability to evaluate the effects of changes in flow on juvenile chinook migration is limited by our incomplete understanding of the relationship between flow and survival of downstream migrants. Although most researchers postulate that there may be a relationship between the survival of outmigrating salmonids and flow, defining that relationship on Northwest rivers has proven challenging and contentious. Water velocity and travel time are often used as surrogates for flow, but the effects of changes in flow on water travel time are more complex, involving vertical, horizontal and longitudinal mixing, shoreline dampening, lateral spreading and wave effects (USACE 1998).

Researchers conducting studies of the downstream movement of juvenile chinook in the Green River (Wetherall, J.A. 1971), and juvenile sockeye in the Cedar River in the Puget Sound (Seiler 1995, Tabor and Chan 1996, Warner and Coccoli 1996) developed functions describing a general positive relationship between flow and survival of downstream migrants on those rivers. Data to determine whether a relationship between flow and the survival of outmigrating fall chinook exists in the lower Skagit River are unavailable. It is assumed that the influence of a potential flow:survival relationship would be most apparent during dry years when natural flows from the Sauk, Cascade and other tributary systems are depressed and both the Baker and Skagit Projects are refilling reservoir storage, but there are no data to support this assumption for the Skagit River.

Numerous studies have identified that downstream movement of juvenile salmonids in flowing river systems consists of a diel pattern of alternating movement and holding (Williams et al. 1996, Healy

1991). Most downstream movement is nocturnal, except during periods of high turbidity. In a study of juvenile salmonids in the Green River in Puget Sound, peak catches of downstream migrating fall chinook fry occurred during the 6-hour period after sunset (Jeanes and Hilgert 2001). The predominantly nocturnal migration pattern of juvenile fall chinook is theorized to be a response to reduced predation during low light conditions (Healy 1991).

Baker Project load-following operations typically consist of a pattern of generating during daytime hours and ceasing generation during nighttime periods. Quantifying the effect of reduced hourly flows on downstream migrant survival in the mainstem Skagit River would be difficult, and to some extent the effects of nighttime versus daytime generation are somewhat offset by travel time. The effects of Baker project flow changes are observed at the USGS Mount Vernon gage (RM 15.7) approximately 6 to 8 hours after the flow change is observed at the Concrete gage at RM 54.1. A nighttime flow change associated with Baker Project operations becomes an early morning flow change as the wave travels downstream. When the Skagit Project at RM 93.7 follows similar daytime patterns of generation, the effects of a Skagit Project flow change are observed 6-8 hours later when the wave reaches the Baker River confluence, and 13 to 15 hours later when the Skagit Project wave reaches Mount Vernon. Thus, the nearly 40 mile distance between the Skagit and Baker Projects, and the 56 mile distance between the Baker Project and the Skagit estuary causes the effects of reduced nighttime generation to be observed as early morning or daytime flow changes depending on the specific reach of interest, although the effects of flow changes are attenuated as they travel downstream. Under the proposed interim conditions, winter flood control operation of the Baker Project will continue and the reservoirs will be allowed to refill during the spring to achieve summer pool levels. The downstream effects of reservoir pool fluctuations and potential effects of Lower Baker load-following operations on Skagit River habitats will be evaluated as part of the FERC relicensing studies.

5.1.4 Stranding and Trapping

The Lower Baker Plant has operated under a voluntary, gradual unit shutdown program since 1978 to help juvenile salmonids avoid stranding. Under the program, PSE limits the average rate of reduction of river flow whenever the total Skagit River flow falls below 18,000 cfs (measured at the Skagit River USGS gage near Concrete, No. 12194000). The purpose of the protocol is to reduce rapid flow reductions in the mainstem Skagit River consistent with the capabilities of the single generating unit at the Lower Baker Plant.

As river flows drop, streambed areas are exposed and localized depressions within the channel surface may isolate pockets of water from the main river flow. Juvenile salmonids may become stranded on the freshly exposed streambed, or be trapped in isolated pockets of water where they are susceptible to predation and short-term water temperature increases (Jones & Stokes 1985, R.W. Beck 1989). Although PSE ceases generation at the Lower Baker Development as slowly as can be done without causing excess wear on the unit, load-following operations using the single unit can exacerbate the amplitude and frequency of natural flow fluctuations and lead to indirect mortality of juvenile chinook that may be rearing in mainstem and off-channel habitats.

The vulnerability of juvenile salmonids to stranding appears to be strongly related to size; that is, once salmonid fry grow beyond 50 to 55 mm in total length, they are much less susceptible to becoming stranded during rapid reductions in flow. The WDFW reviewed available literature on ramping and concluded that salmonid fry less than 50 mm in length are most vulnerable to stranding (Hunter 1992). The WDFW report was based, in part, on results of studies conducted during relicensing of the Skagit Project. Stober et al. (1982) observed that fry appear to be less susceptible to stranding once they reach a length of 40 mm. Later researchers conducting studies of the upper mainstem Skagit River observed that the mean size of stranded chinook fry was 43 mm, and that 99 percent of stranded chinook fry were less than 50 mm even when salmonid fry larger than 50 mm were in abundance (R.W. Beck 1989).

Hayman et al. (1996) observed that the mean length of wild chinook fry captured in upper Skagit River sites remained relatively constant at about 43 mm through mid-April and then gradually increased to 55 mm by mid-June. They also reported data from a WDFW downstream migrant trap near RM 19 on the mainstem Skagit River and noted that the mean length of wild chinook fry exceeded 55 mm by mid-May. Little information is available on juvenile salmon distribution and abundance specific to the Skagit River immediately below the Baker River confluence. Based on data from studies conducted above and below the immediate project area, it appears that salmonid fry in the mainstem Skagit River below the Baker River confluence are vulnerable to stranding from emergence in January through early June when they grow beyond the size of stranding vulnerability.

When chinook fry grow larger than 50 to 55 mm, their susceptibility to standing is reduced, but larger chinook fry are still affected by potentially becoming trapped in isolated pockets of water as river levels drop. The available data are insufficient to assess whether the rate of flow reductions affects the incidence of fry trapping. Higgins and Bradford (1996) found a large number of fish trapped during a controlled flow reduction in the Bridge River, British Columbia; even though the rate of stage change was one to two inches per hour. Thus, the frequency and magnitude of flow changes associated with load-following operations appears to have a greater influence on potential trapping than the rate of flow reductions.

Researchers conducting relicensing studies as part of the Skagit Project observed that by late July, nearly all chinook fry were absent from the Upper Skagit River (Jones & Stokes 1985). During a study of natural and hydromodified stream bank habitat in the upper and lower reaches of the Skagit River, researchers noted that the vast majority of wild chinook fry had migrated downstream by the end of June (Hayman et al. 1996). The proposed interim conservation measures do not modify existing load-following operations of the Lower Baker Development during the spring months. As part of relicensing activities, Study A-09d Distribution and timing of salmonid fry in the middle Skagit River will help confirm assumptions regarding juvenile chinook timing and distribution and will aid in the design and scope of any appropriate measures to protect this life history phase beyond the existing downramping protocols.

5.1.5 Adult Upstream Migration

The Skagit River system supports what was historically the largest natural chinook run in the Puget Sound ESU (WDFW et al. 1994). Most chinook spawning occurs in Skagit, Sauk and Cascade drainages upstream of the Baker River confluence. However, all chinook destined for upstream spawning areas pass through lower mainstem Skagit River. The adult chinook migration period begins with spring chinook stocks moving upstream as early as June and ends with fall chinook migrating upstream as late as November.

One indication of the success of upstream migration is whether fish are observed in upstream locations demonstrating that they passed through a specific stream reach. Other measures of fish migration are whether the fish were delayed, or expended so much energy that they are unable to successfully spawn. When encountering a reach that is too shallow or too steep to pass through at the prevailing flow, chinook salmon may hold near the base of the obstruction for several days until flow conditions improve to allow passage. During extreme low flow conditions, chinook salmon will expend energy swimming rapidly through short, shallow reaches that may be more easily passed during higher flows.

Under existing conditions, the channel configuration and available range of flows in the mainstem Skagit River does not appear to block the upstream passage of adult chinook; however, there are no data available on the relationship between flows and the amount of energy expended by chinook salmon during upstream passage through the lower Skagit River. Under the proposed interim conditions, the Baker reservoirs will be drawn down during late August and September to provide 115,000 acre-feet of flood control storage capacity by October 1. Drafting the reservoirs during late summer will increase the average daily volume of flow released and should result in improved passage conditions. As part of the proposed conservation measures, additional flow releases from the Lower Baker Development will also be provided during extreme low flow conditions between October 1 and November 15.

5.2 HABITAT ACCESS

5.2.1 Upstream Fish Passage Facilities

Upstream fish passage facilities at the Baker Project consists of a trap-and-haul system including a barrier dam, water supply and distribution system, holding raceways, manual sorting brail, fish lift and truck loading facility. The barrier dam is located at RM 1.1 on the Lower Baker River and guides fish into a trap where they are collected and transported upstream or to other locations depending on the management protocol. The trap is operated year around except for a 2-week shutdown period for annual maintenance just prior to the sockeye run.

A high proportion of the adult chinook collected at the Baker trap are strays from outside the Skagit River system (Currens et al. 2001). Quantitative data regarding the extent of straying among late-returning lower Skagit, upper Skagit, and lower Sauk River stocks are unavailable and interpretations of genetic data are complicated by past Skagit Hatchery (Marblemount) practices. As described in section 4.1, consistent with recommendations from the Baker River Committee, a new protocol has been accepted by the resource agencies wherein, starting in 2002, adult chinook entering the upstream fish passage trap prior to August 1 will be hauled to Baker Lake and released. These early returning adult chinook are expected to be returns from an on-going experiment to establish a naturally reproducing population of Skagit (Marblemount) Hatchery surplus spring chinook (Suiattle River brood stock origin) into the Upper Baker system. Adult chinook entering the trap after August 1 will be transported downstream and released back into the mainstem Skagit River near the town of Hamilton.

During the interim period until a new license is issued, the facility will continue to operate and no major changes are proposed. In coordination with tribal, federal and state natural resource agencies, minor changes in upstream fish passage may be implemented to accommodate fish passage studies being conducted as part of PSE's relicensing activities. A recent review of the fish facility indicated that although the facility may be slightly undersized for large runs of sockeye salmon, the equipment is maintained in operable condition (Montgomery Watson 1999). A review of timing and rate of salmonids captured at the trap over a 10-year period is being conducted to attempt to correlate operational and environmental conditions with trap capture rates to identify additional opportunities for improving upstream passage (see Appendix D, Study A-35).

5.2.2 Downstream Fish Passage Facilities

Downstream fish passage facilities at Upper Baker and Lower Baker consists of a surface collector in the forebay of each facility augmented by full-depth barrier nets to help guide fish to the entrance and a large fish trap and holding facility from which they are transported to the Skagit River for release. The surface collector is a barge located in the forebay that creates attraction flow within a channel. Fish entering the channel are guided over a weir into a hopper that directs them into a pipe to the fish trap, where sampling occurs prior to transport. The surface collector system at Lower Baker is similar, although older and smaller in capacity compared to facilities at Upper Baker.

During a review of the Baker Project fish passage facilities, the Upper Baker system was found to be functioning as designed. The collection barge is in good condition and the trapping facility and guide net are new (Montgomery Watson 1999). In contrast, the Lower Baker collection barge was considered to be in poor condition and no method is available to temporarily submerge the net to pass debris. The condition of the Lower Baker downstream fish passage facility is not considered to affect chinook salmon, since adult and juvenile chinook salmon are not released into Lake Shannon under the current management protocol.

Surface fish collectors were installed in Lake Shannon and Baker Lake in 1958 and 1959, respectively. Subsequently, barrier nets were deployed in both reservoirs to enhance fish guidance to the downstream collection facilities. Barrier nets were first studied in Baker Lake in 1986 in an attempt to evaluate whether a net system could improve guidance of migrating smolts to an existing collection barge (PSE 1999). The first nets deployed, which had a 1-inch square mesh and extended to a depth of 100 ft, were found to be inadequate, and in 1987 small-mesh (0.25 in) nets were positioned adjacent to the fish collection facility. The small-mesh nets were shown to improve barge efficiency and were considered logistically feasible.

In 1988, guide nets were placed in Baker Lake (PSE 2000). These small-mesh (0.25 in) nets, which extended across the entire forebay to a depth of 100 ft, improved fish guidance to the surface collection facility. In 1991, guide nets were extended to a depth of 200 ft, and in 1992 they were extended from the water's surface to the bottom of the reservoir to make them an exclusionary barrier. Also beginning in 1992, barrier nets have been kept in position throughout the year, except during spill events when the tops of the nets are submerged to reduce drag and accumulation of debris.

Cumulative improvements to the net system, coupled with a repositioning of the attraction barge in 1992, increased the effectiveness of the fish collection facility. In 1997, the guide nets were damaged during an extreme spill event, and in 1999, newly designed nets were deployed in the forebay. Figure 5-1 provides a summary of modifications to the net system at Baker Lake and changes in the number of juvenile salmonids passing through the downstream migrant facility.

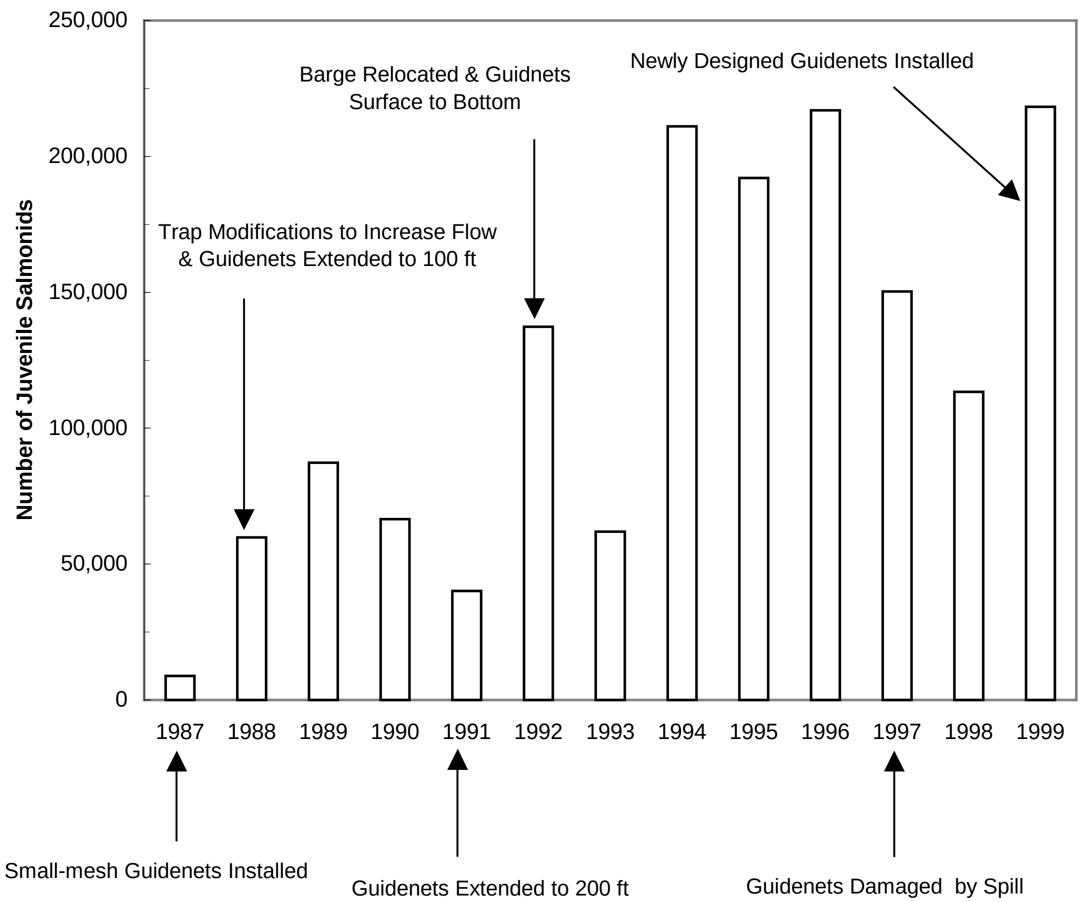

Figure 5-1: Guide-net modifications and the number of juvenile salmonids using the downstream migrant facility at Baker Lake, Washington, 1987 through 1999.

Fixed-location hydroacoustics have been used in Baker Lake to estimate numbers of fish entering the turbine intakes versus those that enter the collection facility (PSE 1998). Based on this method, from 1988 to 1995 the percentage of fish using the bypass was estimated to be 71 percent (average for the seven-year period). Estimated values for each year during this period are shown in Figure 5-2. Although hydroacoustic monitoring continued through 1998, passage estimates were only available through 1995. Tests of hydroacoustics equipment indicated stable performance over the monitoring period, but data were not always correlated with results from fish trapping studies, and "…large and unexplainable numbers of acoustic targets were sometimes counted during non-migration periods (PSE 1998)." Other research has shown that hydroacoustic systems can be unreliable due to interference from non-target sources, such as bubbles and turbulence or resident fish holding in the vicinity of the hydroacoustic array (Mid-Columbia).

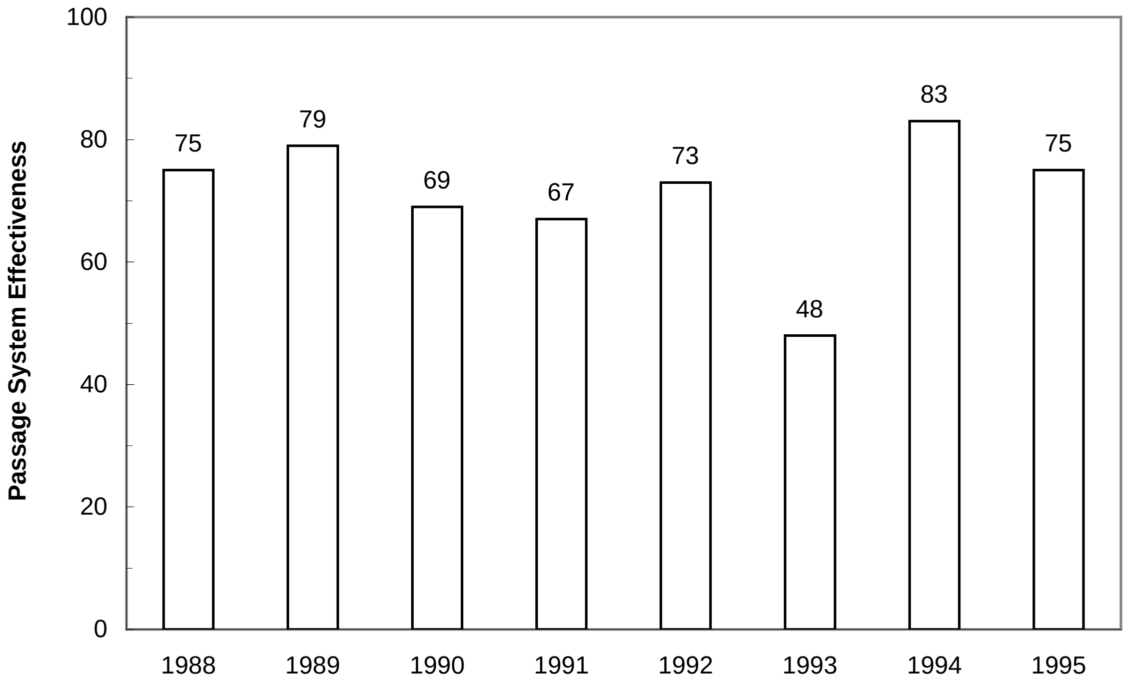

Figure 5-2: Estimated passage system effectiveness based on hydroacoustics monitoring at Baker Lake, Washington, from 1988 through 1995.

Although mark-and-recapture studies have been conducted in Baker Lake, results cannot be used to evaluate passage efficiency. Marked fish are released months before they migrate, and mortality and residualism during the period between marking and downstream migration biases estimates downward. Consequently, the mark-and-recapture studies likely underreport potential passage success. Guide net deployment in Lake Shannon was similar to that in Baker Lake; that is, large-mesh, 100-ft deep nets were replaced with small-mesh barrier nets. However, downstream passage did not improve to the same extent that it did in Baker Lake. Hydroacoustics monitoring and trap counts corroborate that nets have been less effective at the Lower Baker Development than at Baker Lake.

The use of nets at the Upper and Lower Developments is correlated with adult escapement. The number of adult sockeye returning to the Baker River has increased since barrier nets were put in place (Figure 5-3). However, data from the period of record (Figure 5-3) suggested that sockeye abundance was cyclic, indicating factors other than the performance of downstream passage facilities influences escapement. Sockeye populations tend to exhibit cyclic fluctuations and some stocks may exhibit clear brood-cycle dominance (Gustafson 1997).

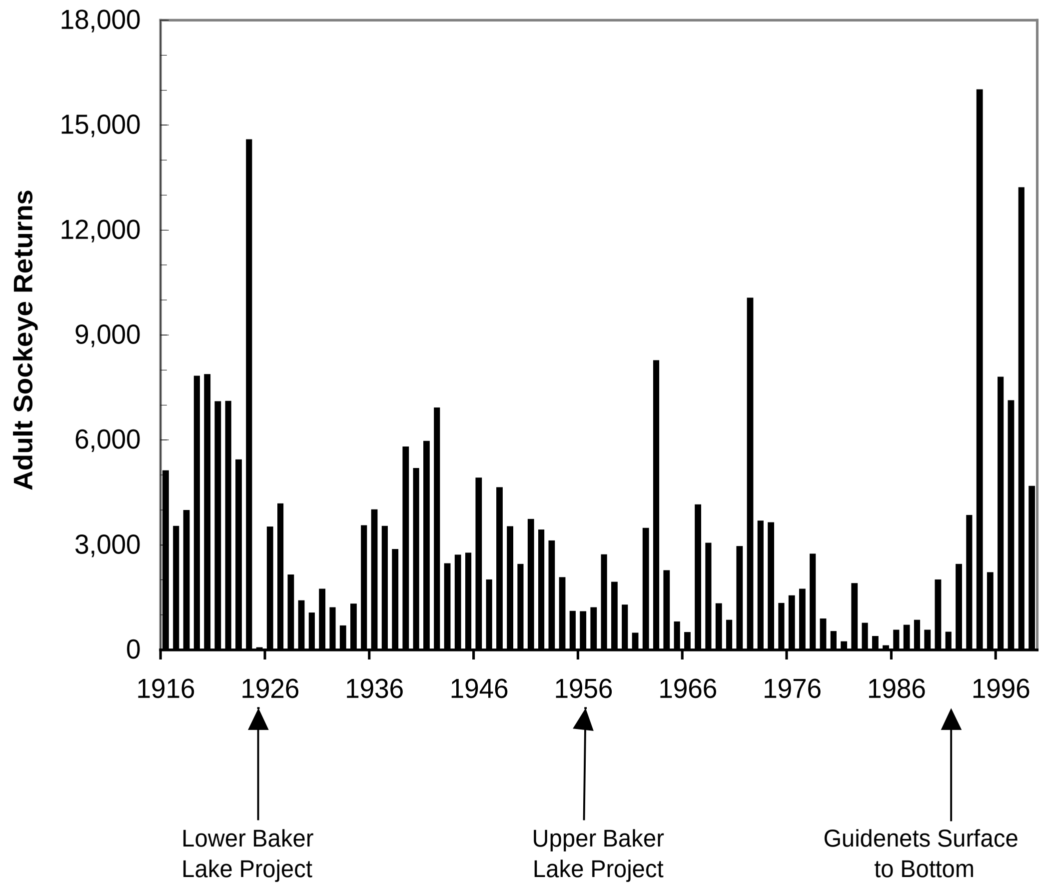

Figure 5-3: Adult sockeye returns at Baker River, Washington, 1916 through 1996.

While the existing surface collector and barrier net at Upper Baker appears to collect and pass smolt – sized salmonids, the success at passing salmonid fry through the reservoir and downstream passage system is less certain. Baker Lake, the reservoir formed by the Upper Baker Dam, covers an area of about

5,000 acres. Chinook fry entering Baker Lake may have difficulty passing through the reservoir and may not be collected at the "gulper" due to the spacing of the louvers. However, under the newly instituted experimental program, adult releases into the Upper Baker watershed are a Skagit (Marblemount) Hatchery surplus spring chinook stock (Suiattle River brood stock origin). The majority of offspring from the spring chinook stock may migrate downstream as smolts and should be more successful at passing downstream through the Upper Baker system due to their yearling size. Due to the recent introduction of these spring chinook adults into the Upper Baker watershed, no data are available to quantify expected passage survival. As described in section 3.2.1, the NMFS is currently revising agency policy regarding the consideration of hatchery fish in ESA status reviews of Pacific salmonids and is expected to issue a new artificial propagation policy by September 2002.

5.3 WATER QUALITY

Water quality in the surface waters of the Baker River drainage is generally excellent. The Baker and Skagit Rivers, as well as the tributaries to the reservoirs, are classified as Class "AA" (extraordinary) by Chapter 173-201 of the Washington Administrative Code. The waters typically meet the "AA" or lake class state water quality standards, although natural pH excursions below pH 6.5 occasionally occur. (Boulder Creek, a tributary to Baker Lake, has had low pH levels due to geothermal activity). According to Washington State Department of Ecology's 1998 303(d) list of "impaired waterbodies," there are no water quality limited rivers or lakes in the project area, therefore Total Daily Maximum Load (TMDL) studies have not been conducted or proposed by Ecology. The high water quality is due to the limited pollution sources in the watershed and a very high runoff per unit area that averages more than 120 inches per year. The relatively short hydraulic residence times in Baker Lake (15 to 80 days) and in Lake Shannon (7 to 30 days) may also limit the potential for water quality degradation.

Since about 1980 the water quality of Baker Lake and Lake Shannon has been monitored by PSE as part of its fisheries management operations. Six stations in the two reservoirs were sampled at the surface and 10 meters on a monthly basis for nutrients, dissolved oxygen, temperature, pH, conductivity, sulfate, alkalinity, major ions, silica, chlorophyll *a*, and total organic carbon.

A limnological study of Baker Lake and Lake Shannon was conducted between August 1962 and October 1964 by the State of Washington Department of Fisheries (Westley 1966). The purpose of the study was to assess the seasonal pattern of water conditions (primarily temperature and dissolved oxygen) in the reservoirs and evaluate the effects of wind, power generation, and spillway releases. The study reported that Baker Lake and Lake Shannon weakly stratified during the summer, with thermoclines between 120 feet and 160 feet in Baker Lake and about 100 feet in Lake Shannon. Turnover occurred in late November and early to mid-December. Dissolved oxygen levels were high, above 9 mg/l, through most of the water column, however, DO concentrations as low as 3 mg/l were reported in Baker Lake below 160 feet. Maximum discharge temperatures occurred in September.

The primary water quality concerns from operation of the project associated with the potential impacts to chinook salmon are total dissolved gas, water temperature and turbidity.

5.3.1 Total Dissolved Gas

Total dissolved gas (TDG) generated by spillway releases from Upper and Lower Baker Dams has the potential to increase TDG levels downstream in the reservoirs' tailraces and in the Baker and Skagit Rivers. The greatest amounts of spillway release occur primarily in November but may occur October through February. During June of 1972, dissolved gas data were collected during conditions with and without spill above and below Upper and Lower Baker dams (Steele 1972). Dissolved gas readings at the Skagit River USGS gage site near Concrete identified a slight increase in both dissolved nitrogen and temperature associated with the influence of the Baker River, but levels of dissolved nitrogen gas saturation in the Skagit River were well below the 110 percent water quality standards. Several samples collected in the lower Baker River above the fish barrier dam during spill events identified dissolved gas saturation levels of up to 117 percent. No obvious effects on fish have been observed over many years of extensive fish passage and research programs in the lower Baker River. Recent research has shown that trauma associated with high dissolved gas saturation levels is initiated as internal lesions and only later are detectable externally. The susceptibility to gas bubble trauma may vary based on size, species and life stage, but laboratory research shows considerable variation. Weitkamp and Katz (1980) state that adults are the most tolerant free-swimming life stage, whereas BPA et al. (1994) concludes that adults are more susceptible than juveniles due to more developed organs. There is general agreement that salmonid eggs exhibit high tolerance to TDG supersaturation. In the Columbia River system, high adult salmon mortality has been associated with prolonged exposure to dissolved gas saturation levels exceeding 120 percent and low mortality at total dissolved gas levels below 112 percent. (Weitkamp and Katz 1980).

Most instances of spill at the Baker Project are associated with peak flow events that occur from October through early February. Few spill events occur during the spring months when juvenile fall chinook are present in the lower Skagit River. The proposed conservation measures will reduce the incidence of fall and early winter spill at the Lower Baker Project that is associated with high levels of dissolved gas saturation. In addition, as part of relicensing activities, a monitoring program is being implemented to characterize TDG, temperature, and turbidity levels in Baker Lake, Lake Shannon, the tailraces, and the Skagit River under a variety of operational, spillway releases, seasons, and flow volumes (HDR 2002). Monitoring began in January 2002 and generally will occur every other week for a minimum of two years. The program may be modified during the monitoring period as new data are collected. Modifications to the monitoring program would be discussed with the Aquatic Resources Working Group, prior to any monitoring program adjustments

5.3.2 Temperature

High water temperatures can affect salmon by altering the timing of adult and juvenile migrations, changing incubation, and hatching intervals, and may contribute to stress-related mortality or reduced growth. Discharge water from the reservoirs is a combination of turbine discharge and surface spill. Based on the earlier limnological study (Westley 1966) and typical patterns for deep reservoirs in the Pacific Northwest, it is possible that Baker Lake and Lake Shannon stratify into two distinct thermal layers in the summer and late fall. The upper warmer layer increases in temperature throughout the summer, while the layer deeper layer remains relatively cold. Because the intakes are withdrawing water from the relatively warmer layer, powerhouse releases may be slightly warmer due to the influence of the reservoirs, although releases have been within State water quality standards. As part of ongoing relicensing studies, available data on water temperature were reviewed but it was concluded that the data are insufficient to adequately assess effects of the Baker Project on water temperature (HDR 2002).

No changes to Project flow releases between January and July are expected as a result of the proposed measures, and thus no effects on water temperature during these months are expected compared to existing conditions. The proposed conservation measures will increase the volume of reservoir releases during August and September when mainstem Skagit River temperatures are typically highest. During October and early November, the magnitude and timing of Project flow releases depend, in part, on the level of Project inflows. During October/November periods of low Project inflow (i.e., less than 85% exceedance value), the proposed measures will augment Project releases to the mainstem Skagit River. During moderate flow conditions, the volume of flow releases to the mainstem Skagit River will be slightly reduced, and during potential flood conditions, a greater portion of Baker inflow will be stored compared to existing conditions. During October and early November water temperatures are typically not a significant consideration and the effects of these flow changes on water temperatures in the Skagit River are expected to be minimal. The monitoring program as described in Section 5.3.1 will provide additional data to evaluate project effects.

5.3.3 Turbidity

Turbidity is elevated in natural streams for short duration during storm and snowmelt events and for longer duration following mass-wasting events. Low levels of turbidity may influence foraging behavior of juvenile salmonids by reducing the distance from which they can located drifting prey (Spence et al. 1996). Higher concentrations of suspended sediments may affect chinook spawning success if fine sediments settle out over spawning redds diminishing intragravel flow by clogging substrate interstices. Baker Project operations influence the transport of suspended material and turbidity through the reservoirs and into downstream reaches.

The Baker Project reservoirs function as sediment sinks. During periods of high sediment influx into the reservoirs, for instance immediately following a mass-wasting event in a reservoir tributary, the reservoirs reduce the downstream transport of fine sediments into the mainstem Skagit River. Thus, the reservoirs serve as settling basins that tend to reduce the magnitude of turbidity events. During repeated cycles of reservoir drawdown, refill and drawdown, such as for winter flood control, fine sediments deposited within the alluvial fans of the reservoir tributaries may be re-suspended causing low-intensity but extended increases in turbidity. During extended periods of low reservoir elevations, wave action and rainfall may allow resuspension of sediments transporting previously deposited sediments to downstream areas. As described in the Water Quality Monitoring Plan developed to address Baker Project relicensing issues (HDR 2002), available data on turbidity were reviewed but it was concluded that the data are insufficient to adequately assess effects of the Baker Project. Between January and July, no changes to Baker Project reservoir operations are expected as a result of the proposed interim conservation measures;

thus, no effects on turbidity during these months are expected compared to existing conditions. The effects of the proposed conservation measures on turbidity during August through December in the Skagit River are expected to be minimal and the Water Quality Monitoring Plan will provide additional data to evaluate project effects.

5.4 ECOSYSTEM FUNCTIONS

Aquatic ecosystems in the Pacific Northwest, including the Skagit and Baker rivers, vary over space and time in response to both natural and anthropogenic disturbances. Under natural conditions, climate, landform, and volcanic activity and wildfire help drive these variations. In the Baker and lower Skagit River systems, many of the geomorphic processes responsible for maintaining aquatic habitats have been altered by activities such as flood control, hydropower generation, agricultural and urban land use and forest harvest. The Baker Project reduces the dynamic nature of the Baker and lower Skagit systems by partially controlling flow, sediment and wood transport in the Baker Basin. The following section contains a summary of the effects of continued operation of the Baker Project on ecosystem processes such as gravel transport, woody debris transport, and floodplain connectivity.

5.4.1 Gravel Transport

The nature and quality of salmonid habitat in rivers is determined, in part, on the transport and instream storage of sediments recruited from upland areas (Spence et al. 1996). In free-flowing river channels, coarse, gravel sized sediment is primarily transported downstream during moderate to high flows and is stored within the channel bed and banks during intervening low-flow periods. Prior to construction of the Upper and Lower Baker Developments, bedload from the upper Baker River and its tributaries would deposit in Baker Lake and intervening low gradient reaches, while sediment entering the system downstream of historic Baker Lake would be transported to the Skagit River. Currently, bedload from the upper Baker River and all tributaries is stored within the reservoirs. There are no tributaries to the Baker River downstream of lower Baker Dam and only episodic slope failures downstream of Lower Baker Dam contribute coarse sediment (gravel-sized and larger) to the mainstem Skagit River.

As part of ongoing relicensing activities, Study A-24, Hydrologic & Geomorphic Analyses (see Appendix D) will provide quantitative information on the ongoing geomorphic effects of the Baker Project on the Baker River, quantify changes in the hydrologic regime of the Skagit River resulting from ongoing Baker Project operations, and will provide an estimate of the volume of sediment that would be delivered to the Skagit River from the Baker River without the influence of the Projects. The evaluation of channel responsiveness will provide a qualitative framework for interpreting potential long-term effects on the channel morphology of the Skagit River.

5.4.2 Woody Debris Transport

Woody debris provides habitat space (pools) and structure (cover), provides habitat and food for aquatic invertebrates, helps retain local deposits of gravel, contributes to bank stability, and can be integral to channel migration processes in alluvial reaches. Researchers studying juvenile salmonid use of mainstem Skagit River margin habitats observed that four to five times more juvenile chinook were observed in margin habitat containing debris piles or rootwads compared to margins containing riprap or single logs (Beamer and Henderson 1998). Once in the river channel, most small pieces of wood are transported considerable distances downstream, while larger pieces are deposited along channel margins. Narrow straight reaches of a river are generally considered source reaches, while lower gradient valley floors serve as woody debris traps (Murphy and Koski 1989). Most alluvial rivers in the Pacific Northwest formerly contained extensive debris jams and, historically, the Skagit River had a debris jam that measured almost 0.75 miles in length and over 1,300 feet wide (Sedell and Luchessa 1982). Removal of in-channel woody debris has occurred throughout much of the Skagit River Basin as a result of timber harvest practices, land-use changes and flood control.

Under existing conditions, the transport of wood from Baker Basin tributaries and reservoir margins has been disrupted, as pieces of wood are either collected and disposed of, or are stranded within the reservoirs. Large woody debris tends to collect at the upper end of both reservoirs due to prevailing wind direction, although the rate of LWD delivery and volume of storage sites within Baker Lake and Lake Shannon are unknown. In past years recreationalists and others have removed a portion of the volume for firewood.

As part of ongoing relicensing activities, Study A-20, Large Woody Debris Management, will provide information on the rate of woody debris recruitment, and the location and composition of wood storage sites within the reservoirs. Future large woody debris delivery to the Baker River basin will be estimated using three separate data sources and methods of investigation. The proposed study approach will develop wood budgets for the Baker River sub-basin over the projected license period comparing the effects of continued project operations to a scenario without the influence of the dams. These estimates will be used to estimate the amount of woody debris that will be intercepted within the reservoirs over the projected license period. Data on the amount of woody debris intercepted, combined with information on the ecological functions of woody debris in reservoir and riverine habitats may be used to assess the relative benefits of wood at each location and provide background information for a long-term woody debris management plan.

5.4.3 Floodplain Connectivity

Rivers construct and maintain channels such that small and moderate-sized discharges (less than or equal to flows with a 2-year recurrence interval) are contained within the channel, while larger discharges that occur less frequently exceed the channel capacity and overflow onto the floodplain. During floods, water is stored in sloughs and side channels, or seeps into floodplain soils recharging groundwater storage. This stored groundwater slowly drains back to the channel, providing a source of cool inflow during the summer (Naiman et al. 1992).

Low-gradient, unconfined channels, such as found in the Lower Skagit River, migrate back and forth across their floodplains in sinuous patterns in response to differential patterns of bank erosion and sediment deposition. Channel migration may occur as a result of slow, steady erosion of the outside of a meander bend, or it may occur as a sudden shift into an old channel during flood events. As a result of these processes, natural low gradient, alluvial channels typically develop a network of low-flow channels containing numerous gravel bars, side channels, abandoned oxbow lakes, sloughs and wetlands. Such off-channel and mainstem margin habitats are an important component of juvenile salmonid rearing habitat within the lower Skagit River providing rearing habitat and refuge from high flows. The formation, availability and quality of off-channel habitat are currently limited due to flood control operations and land-use changes. Channelization and construction of county flood-control levees, revetments and roads has disconnected many formerly accessible side channels. Flood storage operations at the Baker and Skagit projects has reduced some of the large channel-altering flows that historically threatened people and property but were also responsible for creating new side channels. The effects of Skagit River Basin flood control operations, including the existing use of reservoir storage at the Baker Project for flood control, are being addressed under separate section 7 consultations between the Corps and the Services.

Under existing conditions, Corps' flood control operations affect the formation and quality of off-channel and side-channel habitats within the floodplain. The proposed interim conservation measures will increase the flood storage capacity of the Baker Project and is expected to reduce the magnitude of peak Skagit River flood events by approximately 8,100 cfs. Additional flood control capacity at the Baker Project will increase the flood control minimization of side channel and off-channel habitats formation. The proposed interim conservation measures will not affect flow releases at the Lower Baker Project between January and July when fall chinook fry are rearing in mainstem Skagit River habitats. During August and September, floodplain connectivity in the Skagit River will be enhanced due to increased flows associated with evacuation of the Baker reservoirs to provide 115,000 acre-feet of flood storage capacity by October 1.

6. INTERRELATED, INTERDEPENDENT AND INDIRECT EFFECTS

An analysis of the effects of the proposed action on listed species must determine whether the species can be expected to survive with an adequate potential for recovery under the effects of the proposed or continuing action, the environmental baseline, and any interrelated, interdependent and indirect effects. The baseline includes existing operations of the Baker Project and Skagit Project. Interrelated actions are activities that are part of the larger action and depend on the larger action for their justification. Interdependent actions are those which have no independent utility apart from the action being considered. Indirect effects are something that are themselves caused by the action but are later in time. These interrelated, interdependent and indirect effects include floodplain management, ecosystem restoration activities, hatchery and harvest practices, changes to flood control operations and relicensing of the Baker Project and Skagit Project.

6.1 SKAGIT COUNTY FLOODPLAIN MANAGEMENT

The systematic construction of flood control facilities along the middle and lower Skagit River has led to large-scale, long-term alteration of natural riverine environments and processes. Construction of an extensive system of levees and revetments, in combination with flood control by the Skagit and Baker Projects has allowed continued development of the former floodplain. Land uses such as agriculture, urban and residential development, and construction of infrastructure (roads, bridges, drainage systems) have permanently altered the valley landscape. The operation and maintenance of existing flood control facilities by Skagit County is dependent on flood control operations by the upstream hydroelectric projects.

Existing levees and revetments are maintained to prevent damage to agricultural land, public roads and bridges, existing homes and residential areas, or other structures or natural features whose preservation is in the public interest (Skagit County 2000). Maintenance of existing levees and revetments historically included the systematic removal of vegetation. The current guidelines feature methods that encourage the use of rock and retention of soil, vegetation and snags, stumps and trees to enhance fish and wildlife habitat.

6.2 U.S. ARMY CORPS OF ENGINEERS FLOOD CONTROL

As previously described in section 2.2, PSE's license obligates PSE to operate the Upper Baker Development to provide the Corps with 16,000 acre-feet of flood control storage between November 1 and March 1. In addition, PSE is obligated to provide up to 84,000 acre-feet of additional flood control storage if requested by the Corps (for a total of up to 100,000 acre-feet of flood control storage). Under the current agreement between PSE and the Corps, PSE must maintain Baker Lake elevations at or below 720.75 by November 1 (to provide a total of 16,000 acre feet of flood control storage at the Upper Baker Development) and to elevation 707.8 feet or lower under normal operating conditions from November 15 to March 1 (to provide a total of 74,000 acre-feet of flood control storage at the Upper Baker Development). The Lower Baker reservoir pool (Lake Shannon) can be operated in coordination with Baker Lake to provide flood control protection, but there is no formal agreement governing Lake Shannon operations for storage of winter storm runoff. The effects of Skagit River Basin flood control operations, including the use of reservoir storage at the Baker Project for flood control, are being addressed under separate section 7 consultations between the Corps and the Services.

6.3 U.S. ARMY CORPS OF ENGINEERS ECOSYSTEM RESTORATION STUDIES

The Corps, with the support of local sponsors, has initiated several ecosystem restoration studies in the Skagit River Basin designed to improve aquatic habitat conditions.

- *Milltown and Farmed Island Estuarine Habitat Restoration.* During 1999, the Corps arranged to open up earthen levees originally constructed to protect farmland on Milltown and Farmed islands in the Skagit River Delta. The combination of breaching levees and creating new interior dikes opened up about 365 acres of estuarine wetlands for use by juvenile salmon.

- *Skagit River –Avon Bypass.* The Corps and Skagit County are studying the effects of opening up a historic side channel in the lower Skagit River to bypass flood flows around urban areas. This project would provide dual flood control and ecosystem restoration benefits by providing year-round juvenile salmon habitat in the bypass reach.

- *Deepwater Slough Restoration Project.* This project restored tidal interactions to diked lands in the Skagit River estuary. The re-establishment of intertidal marsh, shrub, and forested communities improved physical connectivity and provided additional estuarine wetlands critical to salmonid rearing and osmoregulation functions.

- *Little Baker River Restoration Project.* The objective of this Section 206 Restoration Project is to restore aquatic habitat in an historic side channel in the Lower Baker River alluvial fan.

6.4 SKAGIT COUNTY STRATEGIC PLAN FOR PROTECTING WILD SALMONIDS

The purpose of this program is to identify Skagit County's actions in giving special consideration to anadromous fish and to define the salmon enhancement and protection program. The following text contains excerpts from the County’s Internet site [www.skagitcounty.net/StrategicSalmonPlanOrdinance] describing the variety of salmon protection activities underway in Skagit County.

> “The County will assist other agencies and organizations where appropriate, and encourage protection and enhancement projects that may help restore the natural landscape processes that form and sustain habitat to which salmonid stocks are adapted. This will be accomplished through participation, forming partnerships with others, revising existing codes, implementing a variety of programs and projects, providing public outreach and education, and a commitment to gaining continual expertise, knowledge and understanding.
>
> (2) PARTICIPATION:
>
> (a) Participating in local, regional, state, and federal salmon recovery forums.

The County will continue to participate in local, regional, state, and federal salmon recovery efforts and forums. The County participates in the following forums:

(i) Skagit Watershed Council (SWC): The SWC comprises 36 member organizations, including tribes and other governmental entities, conservation organizations, business and industry groups with interest in salmon recovery in The County. County representatives attend the SWC's regular monthly meetings and sit on the SWC's Restoration and Protection, and Administration Committees.

(ii) Regional Road Maintenance Endangered Species Act Technical Working Group (RRMTWG): The RRMTWG has developed Regional Road Maintenance Endangered Species Act (ESA) Program Guidelines to minimize impacts to salmonids resulting from road maintenance. The County regularly participates in this forum to exchange information and ideas with other local, state, and federal agencies and entities.

(iii) Skagit County Watershed Council: Salmon Recovery Plan: The County has obtained a grant to develop a Salmon Recovery Plan, ESHB 2496: Salmon Recovery Planning and ESA. The intent is to create and implement a salmon recovery plan allowing the County to continue to provide essential government services and receive protection from third party lawsuits under ESA.

(iv) Skagit Council of Governments: Lead agency for HB 2514, Watershed Planning: The purpose is to estimate the amount of surface and ground water in the various basins.

(b) Partnering and/or consulting with appropriate federal, state, and local agencies and entities on salmon recovery issues and projects.

The County will pursue local and regional partnerships where appropriate on both a project and planning basis. This will allow utilization of local salmon recovery expertise to the best extent possible.

The County has entered into memoranda of agreements or professional service agreements related to salmon recovery with the following agencies and entities:

(i) Skagit Fisheries Enhancement Group,

(ii) Skagit Watershed Council,

(iii) Washington Department of Fish and Wildlife,

(iv) U.S. Forest Service, and

(v) Skagit Conservation District.

(3) REVISION OF EXISTING ORDINANCES AND ADOPTION OF NEW ORDINANCES

The County has adopted numerous ordinances beneficial to salmon habitat. These ordinances reduce, mitigate, and/or offset impacts resulting from land use activities. The County will continue to update or adopt land use ordinances as required per federal, state, and local mandates.

The following, plans, policies, and ordinances regulate land use activities that could impact salmonids:

(a) Plans and Policies:

(i) Countywide Planning Policies

(ii) Skagit County Comprehensive Plan

(iii) Watershed non-point action plans: Samish Watershed, Nookachamps Watershed, and Padilla Bay/Bayview Watershed.

(b) Adopted Ordinances:

(i) Critical Areas Ordinance (SCC 14.24), including sections on Ongoing Agriculture on Agricultural Lands (SCC 14.24.120) and Enhancement, Actions and Programs (SCC 14.24.130),

(ii) Clean Water District Ordinance (SCC 6.68)

(iii) Flood Damage Ordinance (SCC 14.34)

(iv) Environmental Policy Ordinance (SCC 14.12)

(v) Drainage Ordinance Adopting Ecology Standards (SCC 14.32)

(vi) On-site Sewage Disposal Ordinance (SCC 12.05)

(vii) On-Site Septic Management Ordinance (SCC 12.05)

(viii) Mineral Ordinance (SCC 14.16.440)

(c) Future Ordinance Amendments:

(i) Forest Practice Ordinance (pending)

(ii) Shoreline Master Program (SCC 14.26)

6.5 HATCHERY AND HARVEST PRACTICES

Hatchery and supplementation practices, often referred to as artificial propagation, have historically been used as partial or complete mitigation for urbanization, hydropower, municipal and agricultural water supply, highway construction or other projects that affect stream habitats. Artificial propagation has also been used to sustain or increase available numbers of fish for recreational and commercial harvest. Under the ESA, artificial propagation is a potential recovery mechanism (Hard et al. 1992). For instance, artificial propagation appears to have reversed the decline in abundance of spring-run chinook salmon in the White River in western Washington (WDFW et al. 1996). However, artificial propagation appears to entail risks as well as opportunities for recovery of Pacific salmon populations. Steward and Bjornn (1990) noted that interactions between hatchery fish and natural fish may result in greater competition for food, habitat, or mates; an increase in predation or harvest pressure on natural fish; potential transmission of disease and deleterious genetic interaction between populations.

In February 2002, the NMFS received several petitions to delist ESUs of Pacific salmon that have hatchery populations that are currently listed as threatened or endangered under the ESA (67 FR 6215). Pacific salmon ESUs affected by the petition include the Puget Sound chinook salmon. The NMFS found that the petitioned actions may be warranted in view of a recent U.S. District Court ruling regarding NMFS' prior treatment of hatchery fish in ESA listing determinations. The NMFS is currently revising agency policy regarding the consideration of hatchery fish in ESA status reviews of Pacific salmonids and is expected to issue a new artificial propagation policy by September 2002. When the NMFS status reviews of Pacific salmonid hatchery stocks are complete, the NMFS will consider whether there is a need to modify listings, critical habitat designations, protective regulations, or ongoing recovery planning efforts (67 FR 6215).

Natural recruitment of fall chinook in the lower Skagit River is supplemented by hatchery releases, such as releases from the Skagit Hatchery. In the 10-year period prior to 1991, an average of 1,472,000 fall chinook salmon were released annually into the Skagit basin (WDFW et al. 1994). Since the number of adult chinook entering the Baker trap is much larger than the number of expected Baker basin returns, most of the chinook entering the Baker trap in recent years are thought to be fish from the lower mainstem Skagit River (Sprague 1995). The WDFW modified the procedure for handling the Baker

River trap beginning in 1995 reducing the number of chinook transported into the Baker system. The WDFW decided that adult chinook entering the trap would have higher reproductive potential if they were returned to the Skagit River. Current fisheries management of the Baker River system is based on the assumption that the original Baker River chinook stock has been extirpated (PSE 2000). The WDFW began introducing Skagit (Marblemount) Hatchery surplus spring chinook (Suiattle River brood stock origin), with an early adult migration pattern, into the Baker watershed in 1999. The intent of the experimental program is to determine if this hatchery stock of chinook (which tend to rear longer in fresh water) will be able to take advantage of habitat above the reservoirs.

Salmon originating from the Skagit River system are caught in both the United States and Canada sport and commercial saltwater fisheries. Hatchery production facilitates a higher harvest rate than wild-spawning populations are able to sustain. Sport angling and Tribal gill net fisheries for chinook and coho salmon and steelhead trout have been active within the San Juan Islands and near the mouth of the Skagit River. Sport and Tribal fisheries also have caught large numbers of returning adult salmon within the mainstem Skagit River. Fishing harvest rates for salmon populations in the Skagit River peaked in the 1980s. Harvest of lower Skagit River fall chinook in some years was estimated to be as high as 70 percent (Sprague 1995). The tribes and WDFW have recently reduced fishing to promote increased escapement.

6.6 FUTURE LICENSING OF THE BAKER PROJECT

The Baker Project license expires in 2006. PSE filed a notice of intent to relicense the Project in April 2001, and plans to file an application to relicense the Project on or before April 30, 2004. In advance of that filing, PSE (as the prospective license applicant) began working with tribal, federal, state, and local agencies, non-governmental organizations and private parties to identify studies and monitoring efforts necessary to support an application to relicense the project.

A total of 35 aquatic-related environmental studies are being conducted as part of the FERC relicensing effort. Several of the study requests were approved in 2001 and field measurement efforts and data analyses are underway. Approval of other study requests is still pending; and some study requests and resultant studies may not proceed. Information developed during relicensing will examine the effects of project operations on listed and non-listed species and their habitats. These studies will allow a more complete understanding of the status and needs of chinook salmon in the Baker and Skagit Rivers to inform the discussions and decisions regarding relicensing of the Baker Project, including further ESA consultation regarding terms and conditions that should be included in the new license. Alternative operational scenarios under consideration will include potential structural modifications to provide increased operational flexibility.

6.7 SKAGIT RIVER HYDROELECTRIC PROJECT (FERC NO. 553)

The Skagit River Hydroelectric Project consists of three dams and associated reservoirs on the Upper Skagit River. Multistage construction of the project began in 1919, and the three dams were completed by 1949. Although various plans to increase the capacity of the Skagit River Project have been considered, its general configuration has remained the same since 1949. Ross reservoir is the largest of the three, with a usable storage capacity of 1,052,300 acre-feet at elevation 1,602.5 ft above mean sea level. An additional 95,000 acre-feet of storage may be obtained at Ross Dam during major floods by surcharge of the reservoir. Diablo and Gorge reservoirs are much smaller with a combined usable storage capacity of 10,935 acre-feet (USGS records 2000). Total active storage capacity of the Skagit Project, not included potential surcharge storage at Ross Dam, is 1,063,235 acre-feet; in comparison, the total active storage capacity of the Baker Project is 307,361 acre-feet.

Ross Dam is the uppermost of the three Skagit Project dams, located at RM 105.2, with Diablo Dam constructed at RM 101, and Gorge Dam at RM 96.6. The Gorge Powerhouse is located 2.4 miles downstream from the Gorge Dam and about 0.5 mile upstream of the USGS gage at Newhalem (USGS Gage No. 12178000). The Skagit Project is typically operated as a load-following power generation plant with the amplitude of Skagit Project downramp events governed by terms of a 1991 Fisheries Settlement Agreement (FERC 1991). The effects of flow fluctuations at the Skagit Project continue downstream but dampen in magnitude and are typically observed as river level changes at the USGS gage near Concrete (RM 54.1) about 6 to 8 hours after the Skagit Project flow change depending on the background flow level. Additional details on the operational characteristics of the Skagit Project are described in section 3.3.1 and Appendix D.

The effects of power generation and flood control operations at the Skagit and Baker Projects have potential cumulative, additive and synergistic effects on chinook salmon in the lower mainstem Skagit River. Interim conservation measures described in section 4.4 were developed in recognition of these potential effects, and coordination between operations at the two projects is proposed to reduce potential impacts of project interactions. The proposed Coordinated Flow Management Plan is designed to take advantage of the travel time between the two projects to provide complementary load-following operations that reduce the effects of each project operating independently.

6.8 ANALYSIS OF EFFECTS ON LISTED SPECIES

Aquatic habitat rehabilitation and protection activities undertaken by the Corps, Skagit County Watershed Council, Skagit Council of Governments, Regional Road Maintenance Endangered Species Act Technical Working Group, and the Skagit County Watershed Council: Salmon Recovery Plan will improve habitat conditions for chinook salmon in the Skagit Basin. Increased countywide attention to salmon recovery efforts will complement the conservation measures to be implemented by PSE as part of continued operations of the Baker Project.

7. SUMMARY ANALYSES OF EFFECTS

The purpose of this BA is to determine if operation of the Baker Project pending relicensing with proposed interim conservation measures, developed in consultation with the Services and FERC, will have an adverse effect on ESA-listed species and, if appropriate, to provide analyses of project impacts to those listed species and any designated critical habitats that are likely to be found in the project area. Determining the effects of a proposed action typically follows a matrix of pathways, through which habitat degradation could occur, and indicators of those effects. A matrix of pathways and indicators was originally developed by the USFWS to evaluate the effects of grazing, and later modified to evaluate effects of timber harvest activities (1999b). The analysis of the effects of the Baker Project operations followed a similar evaluation of pathways and indicators that were modified to address action-specific circumstances as recommended by the NMFS (1999b). The definitions of ESA effects determinations are not identified in the ESA or implementing regulations. However, the regulations define a determination of “likely to jeopardize” as “to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species” (50 CFR 40202). If the project actions are likely to jeopardize the continued existence of a listed species, a formal conference is required.

A summary of the pathways and indicators that guided evaluation of effects of Baker Project operations during the interim licensing period in accordance with the proposed interim conservation measures is provided in Figure 7-1. The BA provides an analysis of project impacts to listed species and critical habitats if they are likely to be found in the project area. Based on this analysis, the BA makes an “effect determination” for the proposed action. In recent NMFS guidance documents, NMFS has indicated that this determination applies not just to the species and critical habitats levels, but also applies at the individual level (NMFS 1999b). The summary effect determination for each indicator is provided in Figure 7-1; supporting rationale for each determination is described in Section 5, Environmental Analyses.

One objective of the BA is to describe the anticipated extent and amount of “take” associated with the proposed action. The ESA defines take as “to harass, harm, pursue, hunt, shoot, wound, trap, capture, collect or attempt to engage in such conduct." Harm is further defined by the NMFS as actions that create significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavior patterns including, but not limited to, breeding, spawning, rearing, migrating, feeding or sheltering (64 FR 60731). Based on these criteria, activities associated with continued operation of the Baker Project may result in the incidental take of Puget Sound chinook salmon. It is not possible to quantify the numbers of fish that will be "taken" for all of the project effects, nor to isolate project effects from the influence of non-project related factors occurring upstream of the Baker River confluence but extending downstream into reaches affected by the Baker Project. These downstream influences may include but not be limited to: daily and hourly flow fluctuations associated with natural runoff from glacial and non-glacial upstream tributaries and the downstream influence of the Skagit Project, effects of hatchery management, harvest and other natural and anthropomorphic influences. Chinook losses may be masked by seasonal or cyclic population fluctuations, or the effects of an overriding natural event such as a major flood or extended drought.

We conclude from our analyses that the operation of Baker Project, in accordance with the proposed interim conservation measures, is not likely to jeopardize the continued existence of the Puget Sound chinook salmon ESU. The downstream effects of the Baker Project extend to the lower Skagit River that represents only a small portion of the Puget Sound chinook ESU (Figure 7-2). During fall and winter, the recommended measures will improve chinook spawning and incubation conditions. During spring and summer, the downstream effects of the Baker Project primarily affect Lower Skagit fall chinook fry and juveniles, but could also affect upper Skagit Basin chinook juveniles migrating downstream through the lower river. The Upper Skagit summer chinook stock is considered healthy, while the Lower Sauk summer chinook stock is depressed due to sedimentation issues (WDFW et al. 1994). Spring chinook stocks from the upper Skagit Basin migrate downstream through the lower Skagit River during the spring, but migrate as yearling and older smolts that are less likely to be affected by flow fluctuations during their downstream migration than fry. While the Baker Project will affect chinook fry and juveniles rearing in, or migrating through the lower Skagit River, the magnitude of effect will not reduce appreciably the likelihood of both the survival and recovery of the Puget Sound chinook ESU.

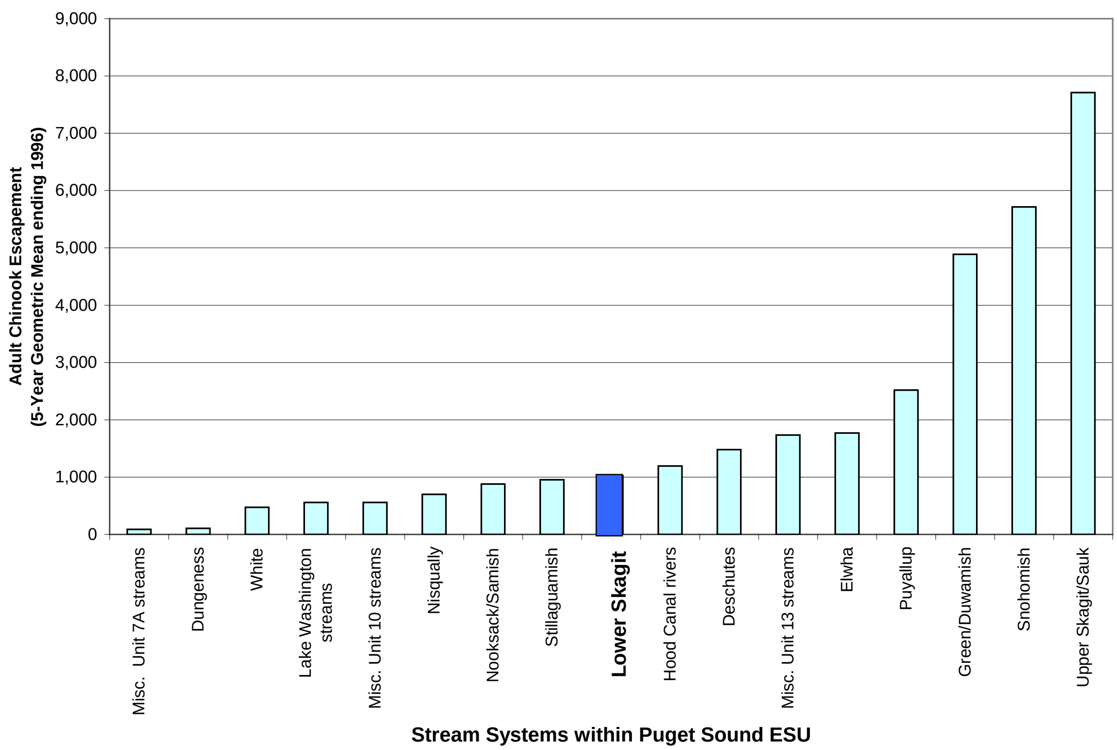

Figure 7-1: Recent 5-year geometric mean spawning escapement for chinook salmon populations in the Puget Sound Evolutionarily Significant Unit. Miscellaneous Units 7A, 10 and 13B designate combine escapements for smaller streams within a fishery management region (Source: Myers et al. 1998).

We conclude that the Baker Project, operated in accordance with the proposed interim conservation measures, may adversely affect Puget Sound chinook salmon because: (1) project startup, shutdown and load-following operations may strand, trap or reduce the growth of juvenile lifestages, and (2) the project may impede the downstream movement of juvenile lifestages. We also conclude that compared to existing conditions, the Baker Project, with the recommended measures, may benefit Puget Sound chinook salmon, primarily by reducing stranding risk and by reducing flood impacts to egg to migrant survival. We assessed the project's effects on chinook salmon and concluded that operation and maintenance of the Project, with the recommended measures, would provide protection and enhancement for Puget Sound chinook salmon compared to existing conditions and would ensure that any adverse effects would be minimal. During the chinook-spawning period, the project would increase flow releases to benefit chinook-spawning habitat in the Skagit River by utilizing reservoir storage during periods of low project inflow. Instream conditions for chinook spawning would also be improved by reducing hourly flow fluctuations associated with load following by coordinating operations with Skagit Project releases. In the event of major storm events, the project would increase chinook survival to outmigration by decreasing the impact of peak floods. We believe the proposed interim conservation measures would not destroy or adversely modify critical habitat and are not likely to jeopardize the continued existence of the Puget Sound chinook salmon.

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Figure 7-2: Summary matrix of pathways and indicators of effects of the proposed interim conservation measures for the Baker River Hydroelectric Project (FERC No. 2150) on Puget Sound chinook salmon (*Oncorhynchus tshawytscha*) pending Federal Energy Regulatory Commission Baker Project relicensing.

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