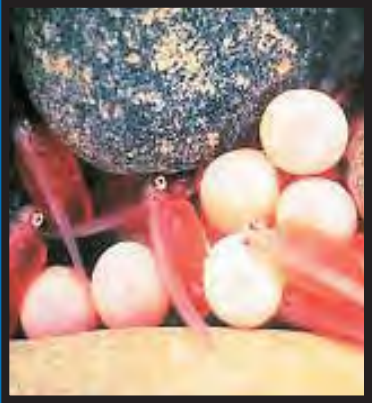
Cedar River Sockeye Hatchery Project Final Supplemental EIS

July 14, 2005



Seattle Public Utilities

City of Seattle
Gregory J. Nickels, Mayor

Seattle Public Utilities
Chuck Clarke, Director

July 14, 2005

Dear Interested Reader:

Seattle Public Utilities (SPU) is pleased to enclose the Final Supplemental Environmental Impact Statement (FSEIS) for the proposed Cedar River Sockeye Hatchery Project (proposed Project). This FSEIS supplements the Final Environmental Impact Statement (FEIS) that was issued for the Project on March 20, 2003. The FSEIS was prepared in response to a decision of the Seattle Hearing Examiner that additional discussion of certain potential environmental impacts from the Project be provided, as well as additional discussion of the Adaptive Management Plan, a mitigation measure for the Project.

The discussion in the FSEIS is meant to further inform decisions to proceed with construction and operation of the Project in light of uncertainties about several environmental impacts. Since there are uncertainties, the FSEIS describes a "worst case" analysis for each issue specified by the Hearing Examiner. "Worst case" is not what is expected to occur, but rather a discussion of what might occur using a variety of "worst case" assumptions. For instance, while the hatchery is expected to adjust its production levels in response to variations in other conditions in the Lake Washington basin, the "worst case" analysis assumes that hatchery production is set at capacity every year.

Discussions of the following uncertainties are found in the FSEIS:

- Genetic interactions with other sockeye populations such as homogenization, domestication, and straying to other parts of the Lake Washington basin. These interactions could be important if it were found that the presence of additional hatchery sockeye caused a reduction in the ability of wild-spawned sockeye to successfully reproduce, either in the Cedar River or elsewhere in the Lake Washington basin.

- Competition and predation related to other sockeye populations and with other salmonids, particularly Chinook, in the Lake Washington basin. These interactions could be important if it were found that the presence of additional hatchery sockeye adversely affected the ability of wild-spawned sockeye or Chinook to find sufficient food resources, or if the presence of additional hatchery sockeye increased the level of predation on other fish species, particularly Chinook which are listed as threatened under the Endangered Species Act.

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- Competition for spawning sites and superimposition related to interactions between sockeye and Chinook spawning in the Cedar River. This could be important if it were found that the presence of additional hatchery sockeye spawning in the river adversely affected the survival of Chinook, which is listed as threatened under the Endangered Species Act.

The FSEIS also contains a discussion of the Cedar River Sockeye Hatchery Adaptive Management Plan. It explains the concept of adaptive management and further discusses how adaptive management is expected to be applied to the uncertainties previously discussed. The Adaptive Management Plan is expected to mitigate potential adverse impacts of the additional production capacity of the replacement hatchery by providing scientific information to managers for use as a basis for adjusting hatchery management to minimize or avoid adverse impacts to wild-spawning sockeye and other species, particularly Chinook.

The DSEIS was circulated for a 30-day comment period, from February 16 through March 21, 2005. A public hearing on the DSEIS was held on March 10, 2005.

SPU received numerous comments on the DSEIS, which have been incorporated into this FSEIS. The FSEIS is organized into two major parts. Part 1 contains a revised Fact Sheet and the body of the FSEIS, including revisions in response to comments. Part 1 also contains revised appendix material, including a new Appendix C to provide additional background information from the literature on the potential effects of domestication selection on fitness in salmonids.

Part 2 contains copies of all written comments received by SPU on the DSEIS, as well as comment sheets and a transcript containing comments from the March 10 public hearing. Part 2 also provides responses to comments on the content of the DSEIS.

The City of Seattle and other decision-makers will be provided the FSEIS to assist them in making decisions regarding the Project.

For further information, please call Vikki Anselmo at 206-386-4560.

Thank you for your interest in this project.

Sincerely,

Chuck Clarke

CHUCK CLARKE
Director, Seattle Public Utilities

Fact Sheet

Project Title and Description

Seattle Public Utilities (SPU) proposes to construct and operate a sockeye hatchery and associated facilities, such as facilities for collecting adult sockeye for broodstock on the Cedar River. As currently planned, the proposed project would consist of a hatchery, a system to supply virus-free water for hatchery operations, and broodstock collection and spawning facilities. Operating protocols, an Adaptive Management Plan, and other documents have been developed to guide future operations and monitoring. The new hatchery would be located at Landsburg, the site of the City of Seattle's municipal water diversion and intake facilities on the Cedar River. Landsburg is located within King County, about 2 miles northeast of Ravensdale and 3 miles southeast of Maple Valley. The broodstock collection facility would be located on the lower Cedar River, either within unincorporated King County or within the City of Renton. Construction of the hatchery is proposed to begin in 2006.

Phased Environmental Review

The environmental review of the proposed sockeye hatchery documented in this Final Supplemental EIS (FSEIS) is part of a phased environmental review process being conducted in accordance with the Washington State Environmental Policy Act (SEPA), RCW 43.21C; WAC 197-11, and the City of Seattle SEPA ordinance, Chapter 25.05 of the Seattle Municipal Code. Programmatic alternatives for the hatchery program were evaluated in the 1999 Final EA/EIS for the Cedar River Habitat Conservation Plan (Cedar HCP). That programmatic analysis has been followed by evaluation of specific project alternatives for constructing and operating a hatchery. SPU conducted scoping and public involvement activities for the project-level EIS during late 2001. The Draft EIS for the Cedar River Sockeye Hatchery Project was issued on September 19, 2002. SPU issued a Final EIS (FEIS) for the project on March 20, 2003. In November 2003, a City of Seattle Hearing Examiner directed that a limited SEIS be prepared to provide a more detailed discussion of one of the project mitigation measures, the Adaptive Management Plan, and a "worst case analysis" for potential significant impacts from operation of the hatchery on native fish stock. The "worst case" analyses include the following areas:

- Genetics, including straying, homogenization, and domestication;
- Predation;
- Competition with other species for food supply;
- Competition for spawning areas; and
- Superimposition of sockeye redds on Chinook redds.

This FSEIS supplements the FEIS for the Cedar River Sockeye Hatchery Project as directed by the Hearing Examiner and does not repeat information included in the FEIS, except where such information is necessary to provide a context for new information presented in the FSEIS. The FEIS and FSEIS encompass all regulatory and other actions necessary to undertake and implement the proposal.

Action Sponsor and Lead Agency

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Permits, Licenses, and Other Approvals Potentially Required

Federal

U.S. Army Corps of Engineers, Section 404 Permits
U.S. Army Corps of Engineers, Section 10 Permit
Section 7 Endangered Species Act Consultation

State

Washington Department of Fish and Wildlife Hydraulic Project Approval
Washington Department of Ecology Section 401 Water Quality Certification
Washington Department of Ecology Construction NPDES Permit(s)
Washington Department of Ecology NPDES General Permit for Upland Hatchery and Fish Farming
Washington Department of Ecology Waste Discharge Approval
Washington Department of Natural Resources Aquatic Lands Lease
Washington Department of Natural Resources Forest Practices Permit
Washington State Historic Preservation Office Cultural Resources Approval
Surface Water Right(s) or Modifications

King County

Shoreline Substantial Development Permit(s)
Commercial Building Permit(s)
Clearing and Grading Permit(s)
Drainage Review
Sensitive Areas Ordinance Review/Public Agency Utility Exemption
Onsite Sewage Disposal Permit

City of Renton

Shoreline Substantial Development Permit
Clearing and Grading Permit (possible)
Building Permit
Drainage Review
Sensitive Areas Review

Authors and Principal Contributors

The Cedar River Sockeye Hatchery Final SEIS has been prepared under the direction of Seattle Public Utilities. The following firms and individuals contributed to the SEIS:

Adolfson Associates, Inc.
- lead SEIS consultant and document assembler

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- scientific lead for competition and predation impacts analysis

Dr. Ernie Brannon, Professor Emeritus, University of Idaho
- scientific lead for spawning competition and superimposition impacts analysis

Issue Date of Draft Supplemental EIS

February 16, 2005

End of Comment Period

March 21, 2005

Final SEIS Issue Date

July 14, 2005

Public Hearing on Draft Supplemental EIS

A public meeting to provide comments was held on March 10, 2005 from 7:00 to 9:30 PM at Renton Technical College (3000 N.E. 4th St., Renton) in Blencoe Auditorium (Building C).

Availability of the Final Supplemental EIS

Copies of the FSEIS and/or Notices of Availability have been distributed to a number of agencies, organizations, and individuals as noted in the Distribution List located in Appendix A.

Copies of the FSEIS are available for review at the following locations

Location	Address
Seattle Public Utilities	700 5th Avenue, Suite 4900 PO Box 34018 Seattle, WA 98124-4018 Contact: Vikki Anselmo (206) 386-4560
Seattle Department of Planning and Development Public Resource Center	700 5th Avenue, Suite 2000 P.O. Box 34019 Seattle, WA 98124-4019 (206) 684-8467
Seattle Central Library	1000 4th Avenue Seattle, WA 98104 (206) 386-4636
University of Washington, Seattle Campus Suzzallo Library	University of Washington Seattle, Washington 98195
Maple Valley Public Library	23720 Maple Valley Highway Maple Valley, Washington 98038
Fairwood Public Library	17009 140th Avenue SE Renton, Washington 98058
Renton Public Library	100 Mill Avenue South Renton, Washington 98055

Appeal of the FSEIS

Appeals of the adequacy of the FSEIS must be submitted to the Office of the Hearing Examiner by 5:00 p.m. July 29, 2005. Appeals should be addressed to the Hearing Examiner in writing and shall indicate the factual objection to the FSEIS and the basis for the appeal, consistent with requirements in SMC 25.05.680. The Hearing Examiner Rules are found in Chapter 3.02 of the Seattle Municipal Code. Appeals must be accompanied by a $50.00 filing fee in a check payable to the City of Seattle. The appeal must be sent to:

Office of the Hearing Examiner
P.O Box 94729
700 Fifth Avenue #4000
Seattle, WA 98124-4729

Nature and Approximate Date of Final Action by Lead Agency

The City of Seattle and other decision-makers will use this FSEIS when making decisions regarding the proposal. Because the FEIS and FSEIS encompass all regulatory and other actions necessary to undertake and implement the proposal, there is no single date for agency action.

Subsequent Environmental Review

No subsequent environmental review is planned. If the proposed project is modified in the future in a way that would be expected to increase the extent or duration of significant adverse environmental impacts, additional environmental review may be necessary.

Documents Incorporated by Reference

The following document is incorporated by reference in this FSEIS:

- Final EIS for Cedar River Sockeye Hatchery Project, March 2003, including Addendum #1

Location of Background Data

Seattle Public Utilities
700 5th Ave. Suite 4900
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Seattle WA 98124-4018
Contact: Vikki Anselmo
206-386-4560

Cost to Public

One copy of the FSEIS is provided free. Additional copies are provided at cost. Copies (either hardcopy or CD) can be obtained by contacting Vikki Anselmo at the address and phone number listed above. In addition, the document may be found on the Seattle Public Utilities website: http://www.seattle.gov/util/About_SPU/index.asp

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Final Supplemental EIS

July 14, 2005

Chapter 1
Summary and Background

1.1 Introduction

1.1.1 Purpose and Scope of this Document

Seattle Public Utilities (SPU), a department of the City of Seattle, proposes to construct and operate a sockeye hatchery and associated facilities on the Cedar River. The proposed hatchery would be capable of producing up to 34 million sockeye fry annually. The hatchery would be located at Landsburg, in southeast King County, about 2 miles northeast of Ravensdale and 3 miles southeast of Maple Valley (Figure 1-1).

SPU issued a Final Environmental Impact Statement (FEIS) for the Cedar River Sockeye Hatchery Project on March 20, 2003. A citizen appealed the adequacy of the FEIS to the Seattle Hearing Examiner. On November 12, 2003, the Hearing Examiner remanded the FEIS to SPU and directed SPU to prepare a Supplemental Environmental Impact Statement (SEIS) that would provide additional information and analysis on two distinct, though related, issues.

First, the Hearing Examiner directed SPU to provide a "worst case" analysis of potential significant impacts from construction and operation of the hatchery upon other fish populations within the Cedar River watershed. The impact analysis in this FSEIS includes a discussion of potential genetic impacts (including homogenization, domestication, and straying[1]); the impacts of predation; the impacts from competition with other species or stocks on the food supply for fish in Lake Washington; the impacts of competition for spawning areas; and the impacts from superimposition of sockeye redds on Chinook salmon redds.

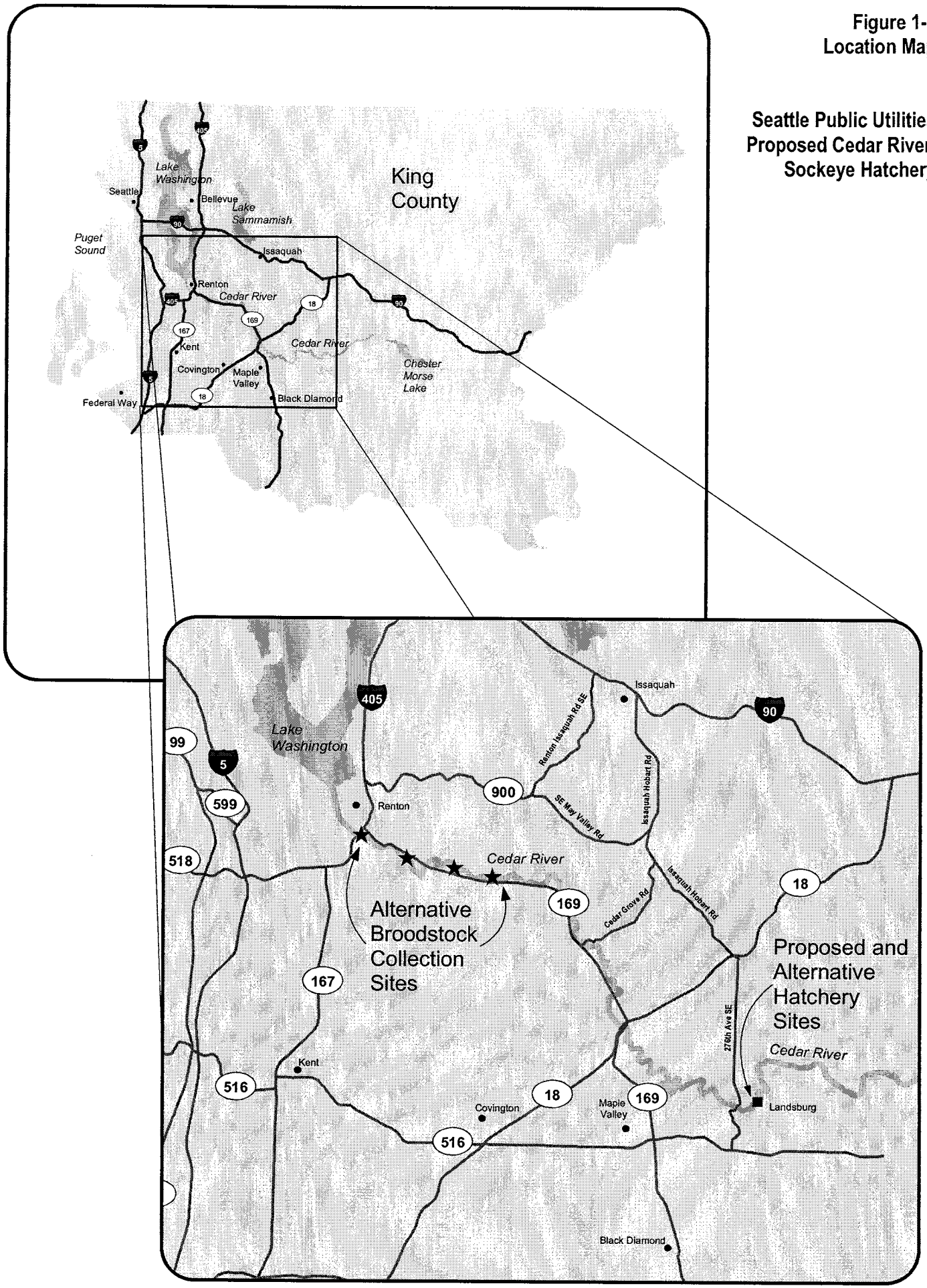
Second, the Hearing Examiner directed SPU to provide more details about how SPU's proposed Adaptive Management Plan will address the potential impacts from the hatchery, including the potential effect of increased sockeye production on existing fish~~eries~~ populations in the Lake Washington basin.

With respect to all other issues addressed in the appeal, the Hearing Examiner's decision affirmed the adequacy of the FEIS. In particular, the Hearing Examiner's decision did not require any additional environmental analysis regarding design and siting issues for the hatchery facilities themselves, including the hatchery building, water supply development, and broodstock

[1] These and other technical terms are defined in the Glossary (Chapter 5).

Figure 1-1
Location Map

Seattle Public Utilities
Proposed Cedar River
Sockeye Hatchery



collection facilities. The State Environmental Policy Act (SEPA) rules and Seattle Municipal Code (SMC) 25.05.620 direct that an SEIS "should not include analysis of actions, alternatives, or impacts that is in the previously prepared EIS." The scope of this FSEIS is, therefore, limited to the two issues described above: a worst case analysis and the Adaptive Management Plan.

1.1.2 Organization of FSEIS

This FSEIS is organized into two main parts. Part 1 contains References, and Appendices from the DSEIS, where changes have been made to reflect comments received on the DSEIS. All text that has been added, deleted, or revised since issuance of the DSEIS is shown in underline and strikethrough.

Chapter 1 of this FSEIS describes the project history and background, lists the objectives of the project, discusses previous environmental review that has been completed, provides an overview of the Adaptive Management Plan for the hatchery, and explains what a worst case analysis is and the methods used to perform the analysis. The chapter then summarizes the major conclusions of the FSEIS and remaining areas of controversy and uncertainty.

Chapter 2 of this FSEIS provides more detail about the Adaptive Management Plan, as it has currently been developed, as required by the Hearing Examiner. This description includes response actions and general measures of success or failure for the response actions.

Chapter 3 of this FSEIS then presents the worst case analysis for each topic. It also explains how the Adaptive Management Plan will address specific potential impacts of the hatchery.

References cited in the FSEIS are listed in Chapter 4. Technical terms are defined in Chapter 5.

Part 1 of the ~~T~~the FSEIS also includes three~~two~~ appendices that provide additional details and supporting information. Appendices A and B appeared in the DSEIS, while Appendix C has been included to provide additional information on potential effects of domestication selection on fitness-. These appendices are referenced in the FSEIS chapters where appropriate.

Part 2 of the FSEIS contains comments received on the DSEIS, and responses to those comments.

1.2 Project History and Background

1.2.1 Project Description

SPU proposes to construct and operate a sockeye hatchery and associated facilities (such as facilities for collecting adult sockeye for broodstock) on the Cedar River. The proposed project will implement certain aspects of the Landsburg Mitigation Agreement, which was established as part of the Cedar River Habitat Conservation Plan (Cedar HCP). As currently planned, the proposed project would consist of a hatchery, a system to supply virus-free water for hatchery

operations, and broodstock collection and spawning facilities. Operating protocols, an Adaptive Management Plan, and other documents have been developed to guide future operations and monitoring.

The new hatchery would be located at Landsburg, the site of the City of Seattle's municipal water diversion and intake facilities on the Cedar River. Landsburg is located within King County, about 2 miles northeast of Ravensdale and 3 miles southeast of Maple Valley. The broodstock collection facility would be located on the lower Cedar River, either within unincorporated King County or within the City of Renton.

1.2.2 SPU Operations on the Cedar River

SPU is a department of the City of Seattle that provides water supply, sewer, drainage, solid waste, and engineering services. SPU's water supply operations provide drinking water to over 1.3 million customers in the greater Seattle metropolitan area. Two-thirds of this supply comes from the Cedar River via a diversion dam and water supply intake at Landsburg. Water supply facilities at Landsburg have been in operation since the early 1900s. Water diverted at Landsburg is then delivered, via an aqueduct crossing the Cedar River and two large supply pipelines, to Lake Youngs, which serves as a water supply reservoir. Since 2003, SPU has operated fish passage facilities to allow upstream and downstream passage of all fish species except sockeye.

1.2.3 Cedar HCP and Agreements

To help guide its water supply and hydroelectric facility operations and its land management activities in the Cedar River watershed, and to obtain incidental take permits under the federal Endangered Species Act, the City of Seattle developed and implemented the Cedar HCP.

The City of Seattle, along with state and federal agencies, approved the Cedar HCP in April 2000. The City and federal and state agencies entered into three additional agreements related to the Cedar HCP:

- The Landsburg Mitigation Agreement sets forth the City's obligations for mitigating the effects of its facilities at Landsburg.
- The Cedar River Instream Flow Agreement binds the City to provide certain flows downstream of Landsburg Diversion Dam.
- The Implementation Agreement ensures implementation of the terms of the Cedar HCP; describes remedies and recourse should any party fail to perform its obligations as set forth in this agreement; and provides certainty that the City's compliance with the terms of the Cedar HCP, the incidental take permit, and the Implementation Agreement will fully address the City's potential legal obligations under the Endangered Species Act with respect to the covered activities and covered species.

The Cedar HCP is a 50-year comprehensive plan that addresses watershed management, instream flows, fish passage at Landsburg, and other issues related to protecting and enhancing habitat for threatened and endangered species, including Chinook salmon and bull trout. The agreement includes the construction of a fish ladder to allow all salmon species except sockeye to spawn above Landsburg Diversion Dam. Because sockeye salmon spawn in relatively large numbers, they would pose a risk to the City's unfiltered drinking water supply if they were allowed above the dam. Therefore the City, with the concurrence of state and federal regulators, has pursued the option of constructing a sockeye salmon hatchery instead of allowing sockeye salmon above Landsburg. The Landsburg Mitigation Agreement memorializes the conditions agreed to by the City and the other governmental agencies with regulatory authority. Parties to the Landsburg Mitigation Agreement include the City of Seattle, represented by SPU; the State of Washington, represented by Washington Department of Fish and Wildlife (WDFW); the National Marine Fisheries Service (now referred to as NOAA Fisheries); and the U.S. Fish and Wildlife Service.

Subsequent to approval of these agreements, NOAA Fisheries and the U.S. Fish and Wildlife Service issued incidental take permits to the City. The City has been implementing elements of the Cedar HCP and Landsburg Mitigation Agreement since that time. The proposed hatchery, with a capacity to produce up to 34 million sockeye salmon fry annually, is one mitigation action prescribed by these agreements.

1.2.4 Existing Interim Hatchery

Prior to the Cedar HCP and Landsburg Mitigation Agreement, the Washington State legislature in 1989 passed Washington State Senate Bill 5156 (codified in RCW 77.100) that ultimately resulted in~~enabled~~ the construction of a sockeye hatchery on the Cedar River. A Cedar River Sockeye Policy Committee was authorized by RCW 77.100.110 and included members from WDFW, NOAA Fisheries, the Muckleshoot Indian Tribe, and SPU. King County was subsequently added to the committee. The committee decided to initiate an emergency sockeye supplementation effort to help address the decline of Lake Washington sockeye salmon populations, and to gather information to guide the development and implementation of an effective long-term sockeye mitigation program.

In response to this directive and in cooperation with WDFW, SPU constructed an interim sockeye hatchery in 1991 immediately downstream of the Landsburg Diversion Dam. The interim sockeye hatchery, managed by WDFW, has been operated on a seasonal basis since 1991. The interim sockeye hatchery uses a temporary weir at River Mile (RM) 6.5 for broodstock collection. The interim sockeye hatchery has three main purposes:

- To conduct prototype testing of recently developed sockeye culture techniques;
- To provide additional fry to support sockeye returns to the Cedar River; and
- To provide a source of marked sockeye fry to facilitate monitoring and life history research to evaluate factors related to the decline of sockeye stocks in the Cedar River.

The interim sockeye hatchery has a capacity to produce approximately 17 million fry per year. Sockeye fry production has been limited in some years by the inability to collect sufficient broodstock. Fry production has ranged between 600,000 and 17 million fry annually. The operation of the interim sockeye hatchery at Landsburg since 1991 has provided an opportunity to evaluate methods that are unique to sockeye culture and test their effectiveness. Methods that were developed in Alaska to control a viral disease (IHN virus) that is common in sockeye populations have proven effective at the Landsburg site. In addition, useful information on incubator performance, water supply, incidence of virus, development rates, emergence timing, and other parameters has been generated through the operation of the interim hatchery.

While experience with the interim sockeye hatchery has been valuable in guiding design and program decisions for the proposed permanent replacement hatchery, the interim facility has operated past its design life. Other limitations with the existing interim sockeye hatchery reinforce the need for a permanent facility. The interim sockeye hatchery has a production capacity half of that agreed to through the~~required by the Cedar HCP and~~ Landsburg Mitigation Agreement, is at risk of damage from major floods, provides limited temperature control of the water supply that accelerates the development rate of sockeye eggs, and has no fry holding capacity. The lack of temperature and holding capacity requires the release of sockeye fry into the river before they would otherwise emerge from spawning gravels under natural conditions.

An additional limitation is that fish passage improvements downstream of the Landsburg Diversion Dam now allow adult sockeye to spawn close to the existing interim hatchery. The presence of adult sockeye carcasses in the vicinity of the open water supply for the interim hatchery increases the risk of transmitting IHN virus. IHN virus is present in the Cedar River sockeye population and could be transmitted to the hatchery by animals that come in contact with salmon carcasses and then the water supply.

1.2.5 Sockeye Mitigation Requirements

The proposed Cedar River Sockeye Hatchery would be capable of producing up to 34 million sockeye fry annually as called for in the Landsburg Mitigation Agreement and the Cedar HCP. The Landsburg Mitigation Agreement, which was enacted as part of the Cedar HCP, calls for a number of measures, including the proposed hatchery, to address the blockage of fish passage caused by the City of Seattle's water supply diversion dam at Landsburg.

The proposed hatchery project, along with certain investments in habitat, was selected for implementation after an environmental review for the Cedar HCP that considered several programmatic alternatives. These programmatic alternatives included variations in the timing and size of a new hatchery, or relying solely on downstream habitat protection and restoration. In part based on that programmatic environmental review, the final Cedar HCP and Landsburg Mitigation Agreement call for implementation of a sockeye hatchery capable of providing up to 34 million fry annually as well as investing $1.6 million (1996 dollars) in protecting and improving downstream habitat.

1.3 Project Objectives

In addition to the overall purpose of producing up to 34 million sockeye fry per year, overall objectives identified in the FEIS (SPU, 2003) for the proposed project include:

- Implement the Cedar HCP and Landsburg Mitigation Agreement commitments related to a biologically and environmentally sound long-term sockeye hatchery program that will help to provide for the recovery and persistence of a well-adapted, genetically diverse, healthy, harvestable population of Cedar River sockeye.
- Avoid or reduce detrimental effects on the reproductive fitness and genetic diversity of naturally reproducing salmon populations in the Cedar River and the Lake Washington basin.
- Monitor the performance and success of the hatchery program and use this information as the basis for evaluating and modifying operations.
- Satisfy any mitigation obligations the City may have for the sockeye migration blockage created by the Landsburg Diversion Dam as defined in the Landsburg Mitigation Agreement, Senate Bill 5156, and other applicable state and federal laws.

In addition to these overall objectives, the Cedar HCP and Landsburg Mitigation Agreement identified a number of project-specific objectives, as summarized in Table S-1 on page S-3 of the Final EIS (SPU, 2003).

The proposed hatchery is expected to augment natural sockeye spawning in the Cedar River and to produce a greater and more consistent number of returning adult sockeye than would result without it. This is expected to increase sport and tribal harvest opportunities of the Lake Washington sockeye salmon fishery.

The objective of the proposed project is to implement a biologically and environmentally sound sockeye hatchery program. The use of hatcheries to augment naturally produced fish stocks has been a controversial issue for many years. Some of the controversy and confusion that has surrounded hatcheries is a result of not adequately separating the influences of fisheries management decisions from the inherent effects of artificial propagation (Brannon and Amend et al., 2004a). Unlike some hatcheries, the goal of the proposed hatchery is to produce an integrated run. The Hatchery Scientific Review Group (HSRG, 2004a) describes an integrated run as follows:

> *A fundamental goal of an integrated [run] program is for the hatchery broodstock to be as similar genetically as possible to naturally spawning populations, in areas where fish are released and/or collected for broodstock. The long-term goal is to maintain genetic characteristics of a local, natural population among hatchery-origin fish, by minimizing genetic changes resulting from artificial propagation and potential domestication. In an idealized integrated program, natural-origin and hatchery-origin fish are genetically equal components of a common gene pool.*

> *A hatchery supporting an integrated program can be viewed conceptually as an artificial extension of the natural environment where the population as a whole (hatchery + wild) is sustained at a much higher level of abundance than would occur without the hatchery. A properly managed integrated broodstock can potentially serve as a genetic repository in the event of a major decline in the abundance of natural-origin fish.*

In another document the HSRG stated, "One goal of integrated hatchery programs is to minimize the genetic effects of domestication by allowing selection pressures in the natural environment to drive the genetic constitution and mean fitness of the population as a whole." (HSRG, 2004b).

1.4 Previous Environmental Review

The environmental review of the proposed sockeye hatchery documented in this FSEIS is part of a phased environmental review process being conducted in accordance with the Washington State Environmental Policy Act (SEPA), RCW 43.21C, WAC 197-11, and the City's SEPA ordinance, Chapter 25.05 of the Seattle Municipal Code. As discussed in Section 1.3.3 of the FEIS, programmatic alternatives for the hatchery program were evaluated in the Final EA/EIS for the Cedar River Watershed Habitat Conservation Plan (1999).

That programmatic analysis has been followed by evaluation of specific project alternatives for constructing and operating a hatchery. SPU conducted scoping and public involvement activities for the project-level EIS during late 2001. The Draft EIS for the Cedar River Sockeye Hatchery Project was issued on September 19, 2002. SPU issued an FEIS for the project on March 20, 2003.

The FEIS (SPU, 2003) evaluated several alternatives for the construction of the hatchery and associated facilities, including:

- Two hatchery sites;
- Two design alternatives for springwater supply;
- Four broodstock collection sites (with and without adult holding and spawning facilities); and
- Three broodstock collection weir designs.

The FEIS also evaluated a No Action Alternative and provided a review of information on project-specific biological effects of the proposed hatchery that updated the programmatic evaluation described in the Cedar HCP FEIS. The purpose of this FSEIS is not to reevaluate these alternatives but to focus on the specific areas required in the Hearing Examiner's decision, discussed in Section 1.1.1 of this chapter.

1.5 Adaptive Management Plan

In early 2000 the City of Seattle assembled a special scientific advisory panel as called for in the Landsburg Mitigation Agreement (LMA). The purpose of this panel was to advise the City and the other signatory Parties to the LMA in developing plans to implement an effective, comprehensive, and biologically sound artificial propagation program consistent with the Cedar HCP. This panel was composed of experts in sockeye salmon biology, Lake Washington ecology, fish diseases, genetics, and recent hatchery reform initiatives. The experts came from the University of Idaho, University of Washington, U.S. Fish and Wildlife Service, National Marine Fisheries Service (NOAA Fisheries), and U.S. Geological Survey.

The experts who have advised SPU on hatchery operations reviewed the status and factors affecting sockeye in the Cedar/Lake Washington basin. They suggested that, "The Cedar River hatchery is a supplementation program. The natural population, therefore, establishes the template on which to guide hatchery operations. Monitoring the population and making sure the hatchery program adapts to the natural changes occurring in the population, without initiating those changes, will be a serious undertaking" (Brannon et al., 2001). Their report further described recommended monitoring and research needs. To be responsive to these recommendations, and because an Adaptive Management Plan was required under the Landsburg Mitigation Agreement and the Cedar HCP, SPU undertook to develop an Adaptive Management Plan for the Cedar River Sockeye Hatchery.

The Adaptive Management Plan will guide management decisions toward meeting the following objectives presented in the Cedar HCP (page 4.3-17):

- The replacement sockeye hatchery should be designed with the capacity to produce up to 34 million fry.
- The program should be designed to produce fry that are similar in quality to those that are produced naturally.
- The program should avoid or minimize detrimental impacts on the reproductive fitness and genetic diversity of naturally reproducing sockeye salmon populations in the Cedar River and Bear Creek basins.
- The program should avoid or minimize detrimental ecological impacts on native salmonids throughout the watershed.

The Adaptive Management Plan is also guided by a number of important provisions listed on page 4.3-17 of the Cedar HCP. These include the need for project guidelines, recognition that future results could influence hatchery production levels, specification of funding commitments, confirmation of the role of the Parties to the Landsburg Mitigation Agreement in making decisions regarding monitoring and production, and a discussion of alternative mitigation.

An Adaptive Management Plan can be helpful in an undertaking where the complexity of biological interactions leads to areas of potentially significant uncertainty in predicting impacts of, and responses to, management actions. In his article "Adaptive Management and Ecological

Restoration," David Marmorek suggests, "Adaptive Management is a problem solving environmental management approach … It involves synthesizing existing knowledge, exploring alternative actions, making explicit predictions of their outcomes, selecting one or more actions to implement, monitoring to determine whether outcomes match those predicted, and using these results to adjust future plans" (Murray and Marmorek, 2003).

Implementation of adaptive management has had mixed results. The concept has proven useful for providing a structure that allows people with differing perspectives to agree to allow controversial natural resource actions to proceed, while working together to develop a greater understanding of the results. At the same time, adaptive management has been challenged to fully integrate scientific input into management decisions. Some believe that adaptive management has failed to compel hard decisions by managers, in spite of scientific results that support these decisions. Nonetheless, when compared with other options for mitigation of potential adverse environmental impacts, adaptive management is often preferred. This is particularly the case when there are significant uncertainties surrounding potential impacts, whether the uncertainty relates to the nature of potential adverse impacts or to the extent and degree of anticipated adverse impacts.

Where adverse impacts are more certain, efforts to minimize, avoid, or compensate for those impacts may be more easily identified and implemented. Where the nature or likelihood of potential impacts is uncertain, however, identifying measures to effectively minimize or avoid them is likewise uncertain and more difficult. One option in the face of a project's uncertain impacts is to prescribe compensatory mitigation. While compensatory mitigation may be certain to confer some environmental benefit in exchange for uncertain impacts, the benefits conferred by compensatory mitigation may have little or no relation to the project's actual impacts and may not directly minimize or avoid those impacts. Adaptive management, on the other hand, is designed to monitor, study, and identify the ***actual*** nature of a project's adverse impacts and provide flexibility to address them directly through changes in the project. Adaptive management also provides the flexibility to address issues that are not currently of concern but might arise in the future.

Implementing an AMP, therefore, represents a more biologically responsive approach to mitigation than compensatory mitigation. It is also consistent with hatchery reform initiatives that seek to ensure that hatchery programs are operated consistent with maintenance of naturally reproducing salmon populations and other watershed goals.

The Landsburg Mitigation Agreement itself speaks to the uncertainties inherent in the operation of the hatchery and the need to manage it adaptively:

> *The Parties also acknowledge that available information on certain complex ecological, genetic and demographic processes is not complete. Therefore, the City, in cooperation with the other Parties, will sponsor and conduct certain studies, as specified in this section E, and act on the results as indicated to manage anadromous fish mitigation in an adaptive fashion.* (p. 13)

In order to develop an Adaptive Management Plan that takes advantage of the latest experience gained through other complex projects, SPU consulted with national experts on adaptive management and worked with local independent scientists to develop a plan and the processes needed to successfully administer it. The implementation of the plan will be guided by a variety of stakeholders and independent scientists and will have avenues for public review and input.

The Adaptive Management Plan for the Cedar River Sockeye Hatchery contains the elements that adaptive management experts recommend (Murray and Marmorek, 2003):

- Identification of uncertainties related to the successful mitigation of potential impacts of the hatchery;
- Development of hypotheses to guide the exploration of these uncertainties;
- Design of a monitoring program that will observe key indices of change in the environment;
- Design and implementation of studies to test the hypotheses;
- A clear process for objective, scientific evaluation of the results of monitoring activities and studies;
- Development of recommendations that are based on scientific evaluation regarding the actions and direction of the sockeye program (e.g., monitoring activities and production levels); and
- Establishment of a decision-making structure that is guided by independent scientific input and meant to include a spectrum of stakeholders in a process that will make the deliberations transparent to the interested public.

These elements combine to constitute an evolving feedback loop. As monitoring results are examined and adjustments to operations are agreed upon, new hypotheses may be developed and new studies then designed to explore them. These efforts, in turn, will generate additional information, which will be evaluated and used to generate the next set of recommended adjustments if monitoring results suggest that changes are needed.

The sockeye hatchery and its Adaptive Management Plan are both specifications of the City of Seattle's Cedar HCP. As such they are both subject to Section 7.2 of that Implementation Agreement, which states: "Failure by the City to ensure adequate funding to implement the HCP may be grounds for suspension or partial suspension of the permit." The Landsburg Mitigation Agreement commits SPU to spending $3,473,000 (1996 dollars) to monitor the performance and potential impacts of the sockeye fry production program (Cedar HCP, p. 4.3-17). Funding is designated for specific activities in specific years over the duration of the 50-year agreement.

Details of the Adaptive Management Plan and its administrative processes are described in Chapter 2.

1.6 Worst Case Analysis

1.6.1 What Constitutes a Worst Case Analysis?

This FSEIS presents a reasonable worst case analysis focused on the issues noted in the decision of the Hearing Examiner. Under Seattle Municipal Code (SMC) 25.05.080, a worst case analysis is required when "information relevant to adverse impacts is important to the decision and the means to obtain it are speculative or not known." Accordingly, the purpose of this FSEIS is to provide information regarding the severity of possible adverse impacts that may occur if the City decides to proceed in the face of uncertainty. SMC 25.05.080 provides that the SEIS must "generally indicate … its worst case analysis and the likelihood of occurrence, to the extent this information can reasonably be developed."

Guidance on the preparation of a worst case analysis under SEPA is somewhat limited because 40 CFR 1502.22, the federal NEPA regulation that served as the model for WAC 197-11-080 and by extension SMC 25.05.080, no longer requires a worst case analysis. The Council on Environmental Quality amended 40 CFR 1502.22 in 1986 to remove the worst case analysis requirement. Moreover, there are notable differences between what was the NEPA worst case analysis requirement and the current SEPA requirement. The NEPA regulation provided that: "If the agency proceeds, it shall include a worst case analysis and an indication of the probability or improbability of its occurrence," whereas, the SEPA requirement reads: "If the agency proceeds, it shall **generally indicate** in the appropriate environmental documents its worst case analysis and the likelihood of occurrence, **to the extent this information can reasonably be developed**" (WAC 197-11-080 and SMC 25.05.080; emphasis added).

The best guidance available on the proper interpretation of the SEPA/SMC worst case analysis requirement is found in the regulatory history of the SEPA rules, and this guidance draws attention to the same language emphasized above. In 1983, the Washington State Commission on Environmental Policy, the agency responsible for drafting the SEPA regulations, issued its Final Report, entitled *Ten Years' Experience with SEPA*. This report provides the following guidance with respect to WAC 197-11-080:

> *The rules use the phrase "generally indicate," recognizing that it is difficult to be very specific at such a level of uncertainty. The requirement for a worst case analysis means that a description is given of how bad things could reasonably be, recognizing that the nature and detail of this description will depend on the extent the information can reasonably be developed. A worst case analysis is intended to be a reasonably probable worst case, and not be an analysis based on an extreme application of Murphy's Law (whatever can go wrong will go wrong).*
>
> *Neither this section nor any other in these rules is intended to require as a matter of law either a strict numerical probability analysis or a formal risk analysis. The appropriate methodology is intended to be governed by the rule of reason. It should be stressed that the purpose of the SEPA procedures is to help make informed decisions about environmental consequences. An environmental*

> *document is meant to serve the difficult job of translating technical analysis, whether in the natural sciences or environmental design arts, into information which can reasonably be understood and used in the public policy arena. Environmental documents are not intended to [be] models of dissertations in predictive physical science, but, rather, an effective way to help public officials and citizens understand the significance of impacts, built upon relevant interdisciplinary analysis.*

Thus, in accordance with this guidance, the worst case analysis SPU has developed and presents in this FSEIS is a description of "how bad things could reasonably be … and not an analysis based on an extreme application of Murphy's Law." Moreover, SPU has not attempted to generate "a strict numerical probability analysis or a formal risk analysis," but has instead generally indicated a worst case analysis in a form that "can be reasonably understood and used in the public policy arena." SPU recognizes that the underlying purpose of SEPA and this worst case analysis is to present information in a useful form to assist decision-makers in making informed decisions about potential environmental consequences.

1.6.2 Methods Used to Develop the FSEIS Worst Case Analysis

Because there is limited information and published studies specific to the Cedar River Sockeye Hatchery relating to the issues identified by the Hearing Examiner for worst case analysis, SPU decided to employ a worst case methodology that brought regional and national fisheries experts together to discuss the issues in a workshop setting. SPU invited 15 regional and national experts from universities and resource management agencies to a workshop designed to identify potential worst case scenarios for identified issues relating to the sockeye fisheries, to discuss the likelihood of occurrence for these worst case scenarios, and to discuss possible outcomes. The workshop was held on April 29, 2004, and addressed specific topics identified in the Hearing Examiner's decision. Three workshop sessions were held concurrently:

1) Genetics of sockeye salmon within the Cedar River and Lake Washington basin, including: straying of hatchery produced salmon into other breeding populations in the basin, homogenization of sockeye salmon populations within the Cedar River system itself, and domestication selection.
2) Predation and competition with other species or stocks for food supply in Lake Washington.
3) Spawning ground competition between sockeye and Chinook, and superimposition of sockeye salmon redds onto Chinook salmon redds.

Each workshop session was attended by four to six recognized experts in these topic areas. One expert at each workshop was assigned to lead the discussion and develop the worst case analysis. The workshop sessions included a facilitator and recorder in addition to the session lead. Workshop participants had a range of experience that included specific knowledge of the Cedar River, knowledge of sockeye and Chinook salmon stocks from both the Cedar River and elsewhere, or similarly applicable knowledge from other basins or other species. Appendix B includes a list of the workshop participants. A summary of each workshop is also provided in

Appendix B. In addition to the workshop participants, observers from interest groups, agencies, and other organizations attended but did not actively participate.

The session co-leads for the genetics issues were Dr. Thomas Quinn from the University of Washington and Dr. Craig Busack of the Washington Department of Fish and Wildlife. The session lead for the competition and predation session was Dr. David Beauchamp from the University of Washington and United States Geological Survey. The session lead for the superimposition session was Dr. Ernest Brannon from the University of Idaho.

1.6.2.1 Worst Case Assumptions

Each workshop participant was provided relevant background materials prior to the workshop. The sessions began with background information about proposed hatchery operations and an introduction to the issues being discussed. The workshop participants received a basic set of recommended general assumptions about the worst case scenario. These assumptions, listed below, included assumptions related to the intended operation of the hatchery as well as assumptions meant to define a reasonable "worst case. "

- It is expected that under normal return conditions, 10% to 20% of the sockeye entering the river would be used for hatchery broodstock. For worst case conditions, it was assumed that up to 30% of the sockeye would be used. This assumption allowed for the worst case in miscalculation of run strength and consequent excessive egg take.
- During low returns, the egg take would be limited so that those returning fish spawned in the hatchery would not exceed 50% of the returning adults. This assumption removed the variability that is proposed under the hatchery operating guidelines and maximized the impact of hatchery production for the competition and predation analysis.
- To represent worst case conditions, it was assumed that the Adaptive Management Plan would be ineffective at detecting or reducing adverse impacts. This assumption removed the ability to speculate about changes in hatchery management that would be assumed to occur in the context of adaptive management, leaving potentially undesirable situations to compound over time.
- Project duration was assumed to be at least 50 years. This assumption was based on the legal length of the HCP commitment, of which the sockeye hatchery is a part.
- A mixture of natural-origin and hatchery-origin returning adults will spawn in the Cedar River, and a similar mixture of natural-origin and hatchery fish will be used as hatchery broodstock.
- For worst case conditions, it was assumed that the escapement goal would be exceeded by 20%. However the superimposition group chose to use 300,000, the current escapement goal.~~This assumption maximizes the impact of higher adult returns on superimposition and spawning ground competition, and on competition for food supply in the lake by the offspring.~~

Each workshop group also developed additional assumptions specific to its own worst case analysis; these are discussed as applicable to each topic in Chapter 3 of this FSEIS.

1.6.2.2 Characterizing the Likelihood and Magnitude of Worst Case Impacts

Once the assumptions were established, each workshop group then proceeded to predict likely changes that could result from the proposed project, based on their current knowledge of the Cedar River system, hatchery operations, and expertise with Chinook and sockeye salmon or other species.

The first step in this process was for each workshop group to identify and agree upon the specific "response variables" or parameters that could be used to measure potential impacts of the proposed hatchery operations. These parameters varied, depending on the topic being addressed. For example, the parameters for the genetics analysis were changes in fitness and genetic diversity; for the predation analysis, the parameter was the percentage change in survival of juvenile sockeye or Chinook salmon under worst case conditions compared to current baseline conditions. Upon determining these parameters, the group then assessed (1) the likelihood of this type of impact occurring, and (2) the magnitude of the impact. The scientists indicated their assessment based on literature review, personal experience in and understanding of the Cedar River system, and understanding of the worst case operating scenarios. Individual workshop participants had the option of using previously prepared blank charts for each response parameter or developing their own assessment methods. All the individuals provided estimates both related to the probability of impacts occurring and the magnitude of the impact.

The likelihood of occurrence and magnitude of impact were typically estimated using ranges of percentages—for example, 0% to 10%, 10% to 20%, etc. Thus, a conclusion about impacts might be "less than a 10% chance of a 20% to 30% reduction in survival over the life of the project." Because there is a lack of empirical data, ranges of potential impacts were used.

The assessments of individual scientists were discussed by the group, and participants could indicate adjustments in their evaluations based on those discussions. Following the individual sessions, all participants convened together and the preliminary conclusions of each session were shared by the session leads with all participants and observers. After the workshop, the session leads wrote summaries of the workshop and circulated these to the participants for comments. The session lead then incorporated the comments as appropriate to complete the summary of the workshop deliberations (Appendix B). The workshop results then formed the basis of much of the worst case analysis presented in Chapter 3 of this FSEIS.

1.7 Major Conclusions of FSEIS

As noted earlier, this FSEIS focuses on issues identified in the Hearing Examiner's decision of November 12, 2003. The worst case analyses were developed in workshop sessions with groups of experts focused on each issue identified by the Hearing Examiner, including (1) potential genetics issues, specifically straying, domestication, and homogenization; (2) predation and

competition for food supply; and (3) competition for spawning sites and superimposition of redds. Each workshop session was led by a qualified scientist.

Workshop participants were provided with a common set of assumptions for a worst case scenario. The groups developed specific evaluation parameters appropriate for their specific topics based on their experience and professional judgment. The workshop participants for the issues related to genetics considered potential impacts to fitness and genetic diversity. The workshop participants considering predation and competition for food supply described potential impacts in terms of overall fitness of the population, or potential impacts on long-term survival. The workshop participants considering competition for spawning areas and redd superimposition discussed the worst case evaluation in terms of potential for reduced Chinook salmon survival. Participants in each session discussed each parameter in relation to the worst case scenario, and the conclusions made during the workshop sessions were used by the session leads to develop the worst case evaluations. The results of these worst case evaluations are summarized below; the detailed evaluations are provided in Chapter 3.

1.7.1 Straying

The potential worst case impacts of straying on naturally spawning Bear Creek and Lake Washington beach subpopulations were evaluated, as discussed below.

Bear Creek Subpopulation. The workshop participants concluded that under the worst case assumptions used for this analysis, there was a high likelihood that some straying from the Cedar River to Bear Creek would occur, but the group concluded that the overall percentage of straying from the Cedar River would be low. The workshop participants also concluded that the expected levels of straying could result in a small reduction to the fitness and genetic diversity within the Bear Creek sockeye subpopulation, but the probability of a negative impact over the 50-year life of the hatchery project is low. Some scientists in the workshop session expressed concern about potential impacts beyond the 50-year life of the hatchery project.

Beach Spawning Subpopulation in Lake Washington. The workshop participants concluded that under the worst case assumptions used for this analysis, straying from the Cedar River to beach spawning areas on Lake Washington is likely to occur, and likely to result in a reduction of fitness and genetic diversity within the beach spawning subpopulation. Because the size of the beach spawning subpopulation is small, it could be more likely to show impacts from straying. It is not likely that the beach spawning subpopulation would be eliminated by this process over the 50-year life of the hatchery project; however, it is possible that reductions in fitness could contribute to the decline of beach spawners, particularly if other factors also adversely affect them. Under the worst case scenario, the project could result in the loss of beach spawning sockeye as a reproducing, distinct subpopulation. The workshop participants found it difficult to apply the “worst case” concept to this subpopulation because its current status and prospects for persistence into the future seem to be affected primarily by factors other than straying from the hatchery.

1.7.2 Homogenization

Under the worst case assumptions used for this analysis, there is high probability that homogenization would occur as a result of hatchery operations, but there would be a low to moderate level of reduction in fitness of the Cedar River sockeye as a result. Under the worst case outcome, there would be complete homogeneity within the Cedar River sockeye populations, with no genetically different subpopulations within the Cedar River system. The workshop participants concluded that a moderate to low reduction in overall fitness of the Cedar River population could reduce the ability of the Cedar River population to react to future changes in environmental conditions. There was no clear consensus among workshop participants about the potential impact to genetic diversity as a result of homogenization; however, most of the participants felt that the impact would be relatively minor.

1.7.3 Domestication

Under the worst case scenario, the workshop participants determined that some level of domestication was likely because the hatchery would unavoidably remove some natural selection pressures from the hatchery-produced component of the sockeye population. The workshop participants concluded that under the worst case assumptions used for this analysis, some reduction in fitness related to domestication is likely. Because of the operating parameters and protocols proposed for the hatchery, the participants concluded that while domestication is likely to occur, the reduction in fitness is expected to be low even under the worst case scenario.

1.7.4 Predation

Under the worst case assumptions used for this evaluation, there is a low likelihood of increased predation on juvenile Chinook in the Cedar River because of hatchery operations. The workshop participants concluded that the hatchery was not likely to change the abundance of predators by stimulating increases in the predator population. The workshop participants thought that there could be a slight alteration in spatial distribution of some predators, specifically to the mouth of the Cedar River and/or the Ship Canal, but that this would have, at worst, a minor effect on the survival of outmigrating Chinook. Workshop participants generally concluded that the increase in the total number of sockeye in the river as a result of the hatchery would “buffer” predation on both naturally produced juvenile sockeye and Chinook because of the greater numbers of fry that could be targeted by approximately the same number of predators. The workshop participants concluded that the hatchery project is highly likely to have neutral or minor effects on the survival of Chinook and sockeye, with a negligible chance of an adverse impact on the survival of populations of either naturally produced sockeye or Chinook as a result of the level of expected juvenile predation.

1.7.5 Food Supply and Competition

The workshop participants felt there is a low likelihood that increased competition for food supply by hatchery-produced salmon will affect other salmon in Lake Washington. Juvenile

Chinook salmon in Lake Washington are unlikely to be affected by competition from the higher density of juvenile sockeye assumed under the worst case scenario because of differences in habitat use and diet between the species, the abundance of prey in the lake, the lack of evidence that the interim hatchery's fry production has affected the food supply in the lake, and the rapid growth rate of Chinook in the lake during winter and spring in years when the interim hatchery operated. Similarly, sockeye are unlikely to be affected because the abundance and composition of prey in the lake currently do not appear to limit their growth or survival in the lake. Some workshop participants noted that these assumptions are based on current levels of abundance and current species composition of prey in the lake, and that factors unrelated to the proposed hatchery, such as global warming or the introduction of new exotic species, could change these parameters and the resulting conclusions.

1.7.6 Spawning Ground Competition

The workshop participants agreed that it is unlikely that spawning ground competition between Chinook and sockeye will occur at significant levels. The workshop participants agreed that under the worst case assumptions used for this evaluation, the effect of increased sockeye density (leading to avoidance behavior by Chinook) on Chinook salmon selection of spawning sites is primarily a nuisance factor, and that the potential risk to Chinook survival from spawning ground competition by sockeye salmon is low. Chinook appear to spend little energy in aggressive behavior toward sockeye, while such expense of energy is greater in Chinook-to-Chinook interactions. Chinook may spawn in different areas than they otherwise might have due to the presence of sockeye, but this represents avoidance behavior rather than competition with attendant energy depletion. The workshop participants felt that alternate spawning sites used by Chinook under these circumstances would likely be equally suitable to potential spawning sites occupied by sockeye.

1.7.7 Redd Superimposition

Some instances of redd superimposition have been observed in the Cedar River system under current conditions, and this is likely to continue under the worst case scenario. However, the workshop participants concluded that even if all Chinook redds in the Cedar River were superimposed with spawning activity from sockeye, the likelihood of significant mortality of Chinook eggs is low. This conclusion was based on the assumption that Chinook are known to be larger fish than sockeye and hence able to dig deeper redds and displace larger substrate than spawning sockeye. The workshop participants felt that the potential impact to Chinook survival from sockeye superimposition under the worst case assumptions used for this analysis is low to non-existent. These findings are consistent with WDFW preliminary data that suggest that a high superimposition rate did not result in low Chinook egg-to-fry survival. It is not known to what extent other factors, such as favorable flow, affected overall survival, but the highest level of Chinook survival occurred in the year when the superimposition rate was also highest.

1.8 Areas of Controversy and Uncertainty

Areas of controversy relating to this project include an ongoing debate about the appropriate role of hatcheries in fisheries management. While this FSEIS provides new information and analysis about potential worst case impacts associated with the Cedar River Sockeye Hatchery, it is not likely to resolve the overall controversy relating to the Cedar River Sockeye Hatchery or hatcheries in general.

As with any natural system, there are several areas of uncertainty associated with the analysis of the project's effects on salmon in the Lake Washington system. Some of the uncertainty is due to the emphasis on integrating hatchery and natural-origin components of the population instead of developing increasingly separate salmon runs. This approach is unconventional and its ability to avoid or minimize hatchery effects is not known with certainty. These uncertainties resulted in the preparation of a worst case analysis as required under WAC 197-11-080.

There are several areas of uncertainty relating to potential genetic impacts to salmon in the Lake Washington system. It is difficult to measure the specific effects of genetic changes because there are so many factors that affect fish survival in the natural environment. Genetic changes often do not result in immediate or distinct consequences; therefore, there are uncertainties associated with how these changes are measured and over what time scales the effects are likely to occur. There is uncertainty over whether the inherent differences between the hatchery and the natural environment will create sufficient selection pressure to significantly lower reproductive fitness in naturally spawning sockeye using the fish culture strategy associated with this program.

There are also uncertainties relating to the ancestry of Lake Washington sockeye, and the extent to which discrete subpopulations exist in either the Cedar River or the larger Lake Washington basin. Because of these uncertainties, the Adaptive Management Plan focuses on the measurement and evaluation of indicators of genetic effects.

There is also uncertainty regarding predation and the competition for food supply in the Lake Washington system. How predators respond to changes in the abundance of food supply is not fully understood. The long-term trends of zooplankton dynamics in Lake Washington are also not well understood. In the absence of direct information, theoretical knowledge and indirect measures have been used to assess the potential response of predators to changes in food abundance.

There is limited information, and therefore accompanying uncertainty, regarding spawning ground competition and redd superimposition in the Cedar River. The analysis in this FSEIS relied on data or observations in other basins, WDFW data on outmigrant Chinook, and observations from the Cedar River.

The Adaptive Management Plan, which is focused on further understanding of these uncertainties, is described in the next chapter. Specific application of the Adaptive Management Plan to each area of uncertainty is further explained in Chapter 3.

Chapter 2
The Adaptive Management Plan

2.1 What is an Adaptive Management Plan, and how does it apply to the Cedar River Sockeye Hatchery?

An Adaptive Management Plan (AMP) is a framework that is designed to avoid, minimize, and mitigate potential adverse environmental effects of a project that may have significant uncertainties. An AMP identifies areas of uncertainty and how project proponents would identify and respond to those uncertainties as the project progresses. The Cedar River and Lake Washington are complex natural systems that are also affected by diverse human activities, and the ecological interactions that could occur as a result of the proposed hatchery project cannot be entirely known even when the hatchery is operational. The proposed Cedar River Sockeye (replacement) Hatchery Project includes areas of uncertainty that warrant development and implementation of an AMP. Therefore, SPU has proposed an AMP based on input from a comprehensive range of experts in fisheries research and management.

Adaptive management is a requirement of the Cedar River Habitat Conservation Plan (Cedar HCP) and the Landsburg Mitigation Agreement (LMA). In early 2000, the City of Seattle assembled a special scientific advisory panel that reviewed the status and factors affecting sockeye in the Cedar/Lake Washington basin and recommended monitoring, evaluation, and research needs. Their findings and conclusions serve as the guiding principles for *The Cedar River Sockeye Salmon Hatchery Plan*. The scientific advisory panel is discussed in detail in Section 2.2.1. The AMP is responsive to the recommendations of the scientific advisory panel and the recommendations included in other program documents that were developed subsequent to the publication of *The Cedar River Sockeye Salmon Hatchery Plan*.

The Cedar River Sockeye Hatchery AMP identifies the current state of knowledge about key areas of uncertainty, possible hatchery impacts, specific questions or hypotheses to be addressed by research and monitoring, possible results, threshold levels that signify potential problems, and possible responses. It defines the decision-making process as well as the roles of the various groups that participate in the scientific evaluation and management of the hatchery program. The AMP also describes project information that will be accessible to the public and describes how the public can provide input to the decision-making process.

The goal of the Cedar River Sockeye Hatchery AMP is to help the hatchery project meet its sockeye mitigation goals while ensuring that risks of long-term adverse impacts to other sockeye populations and other anadromous species are minimized through effective monitoring and management. Specific objectives of the AMP that support this goal include:

- Addressing the primary technical uncertainties with respect to performance and effects of the hatchery program;
- Promoting a high standard for scientific work so that results are credible;
- Effectively communicating scientific results to managers;
- Providing public access to scientific data;
- Providing opportunity for public input to the decision-making process;
- Promoting public understanding of decisions; and
- Utilizing monitoring resources effectively and efficiently.

The Cedar River Sockeye Hatchery AMP is included in full as Appendix A of this SEIS. This chapter summarizes the following major aspects of the AMP:

- How the AMP was developed;
- Goals and objectives of the AMP;
- Implementation schedule;
- The uncertainties that the AMP proposes to address;
- Funding mechanisms;
- Who participates in the AMP decision-making process;
- How the AMP process will be made accessible to the public; and
- The limitations of the AMP.

The AMP is intended to be flexible and to be adjusted over time as necessary to reflect the most current understanding of the Cedar/Lake Washington system. The AMP is not fixed or rigid but is flexible by design and adaptive by definition. As such, the proposed AMP described in the SEIS has been revised from the document described in the FEIS, reflecting additional analyses, new information, and other refinements.

2.2 What process did SPU follow to develop an AMP for the Cedar River Sockeye Hatchery?

2.2.1 Development of Scientific Advisory Panel

In early 2000 the City of Seattle assembled a special scientific advisory panel as called for in the Landsburg Mitigation Agreement (LMA). The purpose of this panel was to advise the City and the other signatory Parties to the LMA in developing plans to implement an effective, comprehensive, and biologically sound artificial propagation program consistent with the Cedar HCP. This panel was composed of experts in sockeye salmon biology, Lake Washington

ecology, fish diseases, genetics, and recent hatchery reform initiatives. The experts came from the University of Idaho, University of Washington, U.S. Fish and Wildlife Service, National Marine Fisheries Service (NOAA Fisheries), and U.S. Geological Survey.

The scientific advisory panel reviewed the status and factors affecting sockeye in the Cedar/Lake Washington basin. Their findings and conclusions serve as the guiding principles for *The Cedar River Sockeye Salmon Hatchery Plan* (Brannon et al., 2001). The panel's findings and conclusions were accompanied by recommendations for monitoring and research activities that they felt would be necessary to address gaps in the science identified during the course of their review. The recommendations from this plan have been used in developing further program documents, including the AMP.

2.2.2 Review of Other AMPs

The development of the proposed AMP for the sockeye hatchery continued with research into past and current efforts by others to implement adaptive management. No examples of the detailed application of adaptive management to hatchery operations were found in the literature; however, there were examples of the use of adaptive management in other natural resource applications. In addition to information gathered from this literature review, the Cedar River Sockeye Hatchery AMP relies on information gathered from two adaptive management workshops sponsored by SPU and Washington Trout in 2001 and 2002. Regional and national experts were brought together to discuss the challenges and lessons learned from previous efforts to develop and implement adaptive management programs. This exchange of ideas and experiences provided guidance concerning how the AMP decision-making process should be structured to promote open and informed decision-making.

2.2.3 Writing and Review of the AMP

The AMP for the Cedar River Sockeye Hatchery was developed by a group of scientists led by Dr. Thomas Quinn of the University of Washington with senior technical review provided by James Lichatowich[1]. The AMP was reviewed by the Cedar River Anadromous Fish Committee (AFC)[2], which is an advisory committee established in the LMA and composed of scientists and stakeholders to provide advice and consultation to the City concerning the implementation of the LMA. Comments from AFC members were reviewed by the authors of the AMP. These comments included questions regarding the level of certainty associated with the effects of domestication selection, assumptions about fry survival rates, how future production levels would be established, whether measurements of fry-to-adult survival were meaningful

[1] Mr. James Lichatowich is a fisheries biologist whose work has focused on salmon management and research in the Northwest. In 1999 he authored *Salmon Without Rivers*, a book that provides a critical assessment of salmon hatchery programs.

[2] AFC membership currently includes representatives from the City of Seattle, WDFW, NOAA Fisheries, U.S. Fish and Wildlife Service, Muckleshoot Indian Tribe, Trout Unlimited, Puget Sound Anglers, Washington Trout, King County, Long Live the Kings, and the public at large.

assessments of fitness, and whether there is a need to establish clear thresholds and responses. SPU has also sought comment on the draft AMP from the Parties to the LMA and from an adaptive management expert, Dr. Barry Gold[3], and SPU provided the draft to the Hatchery Scientific Review Group[4] for their review of the Cedar River Sockeye Hatchery.

As established in the LMA (Section D.2.d), the Parties to the LMA will agree to the AMP after the environmental review process for the hatchery is concluded.

2.3 What are the goals for the AMP?

The primary purpose of the AMP is to help the hatchery program meets its two primary goals of (1) providing sockeye fry to replace those that could otherwise be produced in habitat above Landsburg Diversion Dam, while (2) minimizing long-term adverse impacts to naturally spawned sockeye and other species in the Cedar/Lake Washington system. (See HCP 4.3-12 and 4.3-17.)

The AMP will accomplish this by establishing:

- A starting point for initiating the required research and monitoring of the ecosystem; and
- A decision-making process informed by scientists that effectively addresses the full range of issues that must be considered.

Because scientific resources are not unlimited, it is necessary to prioritize the studies that are needed to address specific areas of uncertainty. The AMP provides a way to strategically coordinate use of resources to derive the maximum benefit. In addition, the AMP calls for a well-managed and timely process to analyze the data and to store the results so that they are consistent and retrievable. The AMP also calls for establishing statistical criteria to be used with the various findings, and thresholds of variation that can trigger changes in hatchery operations. The AMP also identifies how the monitoring program will be funded and the schedule that would be implemented to ensure that information is available so that hatchery managers and decision-makers can respond in an informed manner.

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[3] Dr. Barry Gold is a recognized expert in adaptive management. Dr. Gold led the adaptive management program for the Glenn Canyon Dam Project.

[4] Members of the Hatchery Scientific Review Group (HSRG) are: John Barr, NWIFC (HSRG Vice Chair); Lee Blankenship, Northwest Marine Technology (HSRG Vice Chair); Donald Campton, Ph.D., USFWS; Trevor Evelyn, Ph.D., Department of Fisheries and Oceans Canada (retired); Conrad Mahnken, Ph.D., NOAA Fisheries, Manchester Research Station (retired); Lars Mobrand, Ph.D., Mobrand Biometrics (HSRG Chair); Lisa Seeb, Ph.D., Alaska Department of Fish and Game; Paul Seidel, WDFW; William Smoker, Ph.D., University of Alaska; Thomas Flagg, NOAA Fisheries (alternate). The HSRG was established by Congress in FY2000 to ensure that hatchery reform programs in Puget Sound and Coastal Washington are scientifically founded and evaluated; that independent scientists interact with agency and tribal scientists to provide direction and operational guidelines; and that the system as a whole is evaluated for compliance with scientific recommendations. Further information on members of the group can be obtained at http://www.longlivethekings.org/HRP_HSRG.html.

2.3.1 How will the AMP help the hatchery meet its dual goals of increased adult returns and minimal impact to the naturally produced fish population?

An important focus of the AMP is the collection and analysis of monitoring information needed for decision-makers and advisory groups when establishing annual production levels. This is important because a specific objective of the hatchery is that naturally produced sockeye should compose at least 50% of the total return, on average, over time. Maintaining this level of naturally produced sockeye will maintain natural selection pressures on the Cedar River sockeye population as a whole. Achieving this objective will require hatchery managers to adjust egg collection goals over time. Thus, if natural productivity declines, hatchery production would decline as well. The connection between hatchery and natural production is intended to avoid the replacement of naturally produced sockeye with hatchery returns and to highlight the importance of maintaining habitat quality and biological viability. The AMP establishes the decision-making framework that will guide the setting of annual production goals.

A second focus of the AMP is to help the hatchery project meet its mitigation goals by ensuring that risks of long-term adverse impacts are minimized through effective monitoring and management. The AMP describes several objectives to direct future research and monitoring and suggests how to utilize limited monitoring and research resources effectively and efficiently. The AMP identifies technical uncertainties with respect to performance and effects of the hatchery program. The AMP is intended to promote a high standard for scientific work so that results are credible and are effectively communicated to decision-makers. The AMP describes how results and the decision-making process will be accessible to the public and describes opportunities for public input to the decision-making process.

2.4 What is the implementation schedule for the AMP?

While the Cedar River Sockeye Hatchery is not scheduled to be completed and operating until 2007, the AMP implementation schedule calls for beginning implementation steps in 2005 following the assumed completion of the environmental review process. The schedule for AMP implementation is described in Table 2-1.

Table 2-1. Adaptive Management Plan Implementation Schedule

Activity	Date
Final drafts of AMP, capacity analysis, and operating protocols submitted to Anadromous Fish Committee for recommendation	~~May 2005~~ – August 2005
Parties to the Landsburg Mitigation Agreement make decision to proceed with the AMP	~~June 2005~~ – September 2005
Parties to the Landsburg Mitigation Agreement approve membership and operating guidelines for Technical Work Group (TWG) and Adaptive Management Work Group (AMWG)	June 2006
Monitoring and Research Parties (MRP), TWG, Independent Scientific Advisors (ISA), and AMWG review AMP and operating protocols and recommend any changes to refine/modify criteria and thresholds	July 2006 - January 2007
Development of data management and monitoring protocols (TWG, ISA, AMWG, Parties to the LMA)	January 2007
Establish data management system	March 2007
TWG review annual report on hatchery program and provide comments to AMWG	Annually beginning in 2007
TWG recommend priorities for adaptive management by reviewing existing uncertainties and hypotheses and adjusting as needed to provide direction for the monitoring program	Annually beginning in 2007
TWG review and recommend modifications, if needed, to criteria, thresholds, and responses	Annually beginning in 2007
Annual operating plan submitted by TWG to AMWG for review and approval by Parties to the LMA	Annually beginning in 2007
Review monitoring protocols	Every 5 years

2.4.1 What is the first step in implementing the AMP?

Once the various groups involved in AMP decision-making are formed, an early step in implementing the AMP will be to review the AMP. This review will occur during the year prior to beginning operations of the new hatchery. The primary purpose of this review will be to ensure that the people involved with the implementation of the AMP and who are new to the process have an opportunity to provide input.

Several groups, discussed in detail in Section 2.7, will be involved in AMP decision-making and will participate in reviewing the AMP before it is implemented. In particular, prior to AMP implementation, the Technical Work Group and the Adaptive Management Work Group will be asked to evaluate the list of uncertainties, identify or confirm specific hypotheses for testing, review the monitoring program, and review and confirm (or further develop or confirm) criteria, thresholds, and possible responses.

Adjustments to the AMP are expected during this review as those who will be working on this program apply their knowledge and expertise. For example, the AMP proposes statistical criteria to be used with the various research findings, along with thresholds of variation that can trigger changes in hatchery operations. Setting thresholds for specific criteria helps to provide greater assurance of response if these thresholds are exceeded. The Technical Work Group, in consultation with the Monitoring and Research Parties, will review these proposed thresholds and either confirm them or propose adjustments as appropriate. These recommendations will be reviewed by the Independent Scientific Advisors. Subsequently they will be reviewed by the Adaptive Management Work Group and forwarded to the Parties to the LMA for approval.

2.5 What uncertainties will be addressed by the AMP?

A technical team led by Dr. Thomas Quinn identified specific areas of uncertainty that should be addressed by the AMP. They based their analysis on *The Cedar River Sockeye Salmon Hatchery Plan* recommendations (Brannon et al., 2001), comments to the Final EA/EIS for the Cedar River HCP, and their own research and professional experience. In the AMP these areas of uncertainty are addressed as "null hypotheses," following accepted scientific protocol (this is explained further in Section 2.5.1). The areas of uncertainty that the AMP addresses include:

- The comparability of hatchery-produced and naturally produced sockeye salmon fry;
- The effects of the project on the reproductive fitness of naturally spawning sockeye;
- The effects of the project on sockeye populations outside the Cedar River;
- The effects of the project on Cedar River Chinook salmon; and
- The effects of the project on the aquatic community in Lake Washington.

There is sufficient experience with hatcheries elsewhere to justify concern about these effects, though it is not certain that they will occur. The AMP defines key areas of uncertainty so that hypotheses can be constructed and tested through monitoring and evaluation. Information generated from this process will provide a basis for scientific evaluation and ultimately serve as the basis for changing the program to better meet project goals. Uncertainties and hypotheses are expected to change over time as questions are answered and new ones emerge.

Chapter 3 of this document includes details about how the AMP will address potential effects of the hatchery as reflected in these initial hypotheses. The discussion here is meant to provide a general understanding of the AMP approach and process.

2.5.1 What is a "null hypothesis" and how is it used in the context of the AMP?

The AMP provides a framework to guide future monitoring and scientific study. The AMP identifies specific questions or hypotheses that need to be addressed through scientific research. The AMP presents these questions in the form of direct statements that will be tested using targeted scientific studies. Following scientific convention, these statements are made assuming

that there is no relationship among the variables to be studied. This type of "no relationship" statement is known as a "null hypothesis." Statistical tests are designed to falsify such null hypotheses with stated levels of probability of error. [5]

For example, to address potential differences in fry size between hatchery and naturally produced sockeye salmon fry, the AMP includes the following null hypothesis: "At the time of emergence, there is no difference in size of hatchery and naturally produced fry." This null hypothesis assumes that there would be no difference between the size of hatchery-produced fry and naturally produced fry. The next step in the process would be to develop the scientific study plan to test this null hypothesis. The study plan would include detailed sampling procedures and sample sizes. Power analyses would be used to determine how many samples are needed to have confidence in the results. Statistical analysis of the data generated from the sampling would determine if there is a significant difference in size between hatchery and naturally produced fry (thus disproving the null hypothesis) or if there is no difference in the fry size (thus failing to reject the null hypothesis).

The scientific experts developed several null hypotheses to serve as the basis for a research and monitoring program. The full text of the null hypothesis discussion is included in the AMP (Appendix A). These null hypotheses are summarized in the following sections. For simplicity, the hypotheses are presented here as questions rather than in a null hypothesis format.

2.5.2 How will the AMP determine whether hatchery-produced and naturally produced sockeye salmon fry are comparable?

Until 1991, the Cedar River sockeye population was composed of naturally spawning sockeye salmon (after the initial introductions earlier in the century). Since operation of the interim hatchery began, the population has been composed of both hatchery and naturally produced sockeye. The Parties to the LMA intend the hatchery program to maintain the natural attributes of this composite population so that all fish can successfully reproduce. In keeping with this intent, one objective of the hatchery program is to keep naturally produced and hatchery-produced fry "comparable." Differences could be important if hatchery fry exhibited a handicap or an advantage compared with natural fry that could lead to shifts in the composite nature of the sockeye population and ultimately affect the fitness of sockeye that spawn in the river. The AMP directs that answers to the following questions should be pursued through valid scientific

[5] Statistical analysis of data from sampling may lead to rejection of the null hypothesis (i.e., to a conclusion that there is a difference where the null hypothesis called for no difference). We recognize that this conclusion, based on samples, is not infallible. Statistical tables allow an estimate of the probability that we have rejected the null hypothesis when in fact that null hypothesis is true. It is common practice among scientists to consider anything more than a 5% chance of this kind of error unacceptable, though there are reasons why more or less stringent levels of confidence might be called for. For the purposes of this document, use of terms such as "differences" and "different" in a statistical context implies a less than 5% chance of this kind of error, though the actual levels will be set through the AMP process.

studies to establish whether hatchery-produced and naturally produced sockeye salmon fry are comparable:

- Is there a difference in migration timing between hatchery and naturally produced fry?
- At the time of emergence, is there a difference in size of hatchery and naturally produced fry?
- Does the proportion of hatchery-origin pre-smolts correlate with the proportion of hatchery-origin fry entering the lake?
- Is there a significant difference in size of hatchery and naturally produced fry at the time of pre-smolt surveys?
- At the time of pre-smolt surveys, is there a difference in the proportions of hatchery and naturally produced sockeye compared to the proportions entering the lake as fry?

2.5.3 How will the AMP be used to determine if the project is having an impact on reproductive fitness in naturally spawning sockeye?

Reproductive fitness is represented by the number of offspring produced per adult that survive to reproduce themselves. There are several factors that contribute to reproductive fitness, including the competence of females in selecting, preparing, and defending breeding sites, the number and size of eggs produced by females, and the survival of offspring after emergence. A reduction in reproductive success of the naturally produced fish would reduce the overall productivity of the system and might cause or contribute to the decline of the naturally spawning population. The AMP directs that answers to the following questions should be pursued through valid scientific studies to establish whether hatchery operations are reducing the reproductive fitness of naturally spawning sockeye in the Cedar River:

- Have the size and age composition of the Cedar River sockeye population at maturity remained constant?
- Have the relationships between body size, fecundity, and egg size of female sockeye in the Cedar River remained constant?
- Has the spatial and temporal distribution of spawning sockeye remained constant over time?
- Are there differences in reproductive success between hatchery and naturally produced sockeye that spawn naturally in the Cedar River?
- Has the overall reproductive success of naturally spawning sockeye remained constant over time?
- Has the genetic composition of the Cedar River sockeye population changed over time?

2.5.4 How will the AMP be used to determine if the project is having an impact on sockeye populations in the Lake Washington basin beyond the Cedar River?

The Lake Washington basin includes other populations of sockeye salmon and kokanee (the non-anadromous form of sockeye). Sockeye and kokanee spawn in Bear Creek, Issaquah Creek, and other tributary streams, and sockeye also spawn on some beaches of Lake Washington. These populations contribute to the basin's biodiversity and the overall production of the species. The AMP directs that answers to the following questions should be pursued through valid scientific studies to establish whether hatchery operations are impacting sockeye beyond the Cedar River:

- Are sockeye from populations other than the Cedar River being harvested in Lake Washington at unsustainable levels?
- Is there a significant rate of straying by Cedar River hatchery sockeye into other populations?

2.5.5 How will the AMP be used to determine if the project is having an impact on Chinook salmon in the Cedar River?

The sockeye salmon hatchery program is designed to minimize or avoid impacts to other salmonids in the Cedar River. The Cedar River Chinook salmon population, one of the other salmonid species in the basin, is part of the Puget Sound Chinook Evolutionarily Significant Unit that is listed as threatened under the Endangered Species Act. Chinook and sockeye salmon characteristically use somewhat different spawning habitats, but their spawning habitats overlap in the Cedar River. The AMP directs that answers to the following questions should be pursued through valid scientific studies to establish whether hatchery operations are adversely impacting Chinook in the Cedar River:

- Have broodstock collection facilities changed or delayed Chinook migration?
- Have broodstock collection facilities changed the Chinook spawning distribution?
- Has the digging activity of sockeye salmon in the Cedar River damaged incubating Chinook eggs?
- Have the additional spawning sockeye in the Cedar River resulted in reduced Chinook reproductive success through some other process?

2.5.6 How will the AMP be used to determine if the project is having an impact on the aquatic community in Lake Washington?

Lake Washington serves as the nursery lake for Cedar River sockeye. The lake is a critical rearing and transition habitat between the incubation grounds in the Cedar River (and other tributaries) and ocean feeding grounds. Hatchery production is expected to increase the number

of juvenile sockeye salmon in the lake and this may affect the lake's community. These effects might have ramifications for the hatchery population, naturally reproducing sockeye salmon populations in the basin, and other organisms in the lake. These kinds of effects are difficult to predict because of the complex interactions in the food web, uncertainty about the interactions among various prey and predators, factors controlling the abundance of various components of the community, and uncertainty about the future trends in physical factors that might affect the ecosystem. The AMP directs that answers to the following questions should be pursued through valid scientific studies to establish whether hatchery operations are impacting the aquatic community in Lake Washington:

- Is there a relationship between sockeye abundance and sockeye growth in Lake Washington?
- Is there a relationship between sockeye abundance and the survival rate of salmon in Lake Washington?
- Is there a relationship between sockeye abundance and the abundance of other planktivorous fishes in Lake Washington?

2.6 How is the AMP funded?

The requirement for adaptive management is part of the implementation of the Cedar HCP, which represents a long-term commitment by the City of Seattle. The City funds the Cedar HCP primarily from utility rates charged to utility customers or through funds from bond issues which are repaid through utility rate revenues. Section 7.2 of the Implementation Agreement for the Cedar HCP states: "Failure by the City to ensure adequate funding to implement the HCP may be grounds for suspension or partial suspension of the [incidental take] permit."

The Implementation Agreement specifically references funding commitments for the Cedar River Sockeye Hatchery and its Adaptive Management Plan. Both the Cedar HCP and the LMA specify the City's financial commitments to monitor and adaptively manage the sockeye hatchery program to avoid and minimize potential adverse effects to naturally reproducing sockeye populations and populations of other salmonids. (See HCP 4.5-12 and Table 4.5-1 at 4.5-14.) Under the terms of the LMA, the City is committed to providing up to $7,678,000 (1996 dollars) for the design, permitting (including construction mitigation), construction, and operation of the new hatchery to replace the interim hatchery (LMA Section D.2.a). In addition, the Cedar HCP and the LMA commit the City to spending $3,473,000 (1996 dollars) on monitoring and research to help ensure the success of the mitigation program and to evaluate the performance and potential impacts of the sockeye fry production program (see HCP 4.3-16 and LMA Section E.3.d).

In addition, the City of Seattle provides funding to support HCP implementation that supplements these amounts.

2.7 Who participates in Adaptive Management?

The adaptive management process involves scientists who conduct research and analyze results, policymakers who make decisions about adjustments to the program, and the interested public who can provide input in a variety of ways. The AMP lays out an organizational structure and a decision-making process that is meant to make the implementation of the AMP open and transparent.

2.7.1 Who are the decision-makers and what decisions will they make?

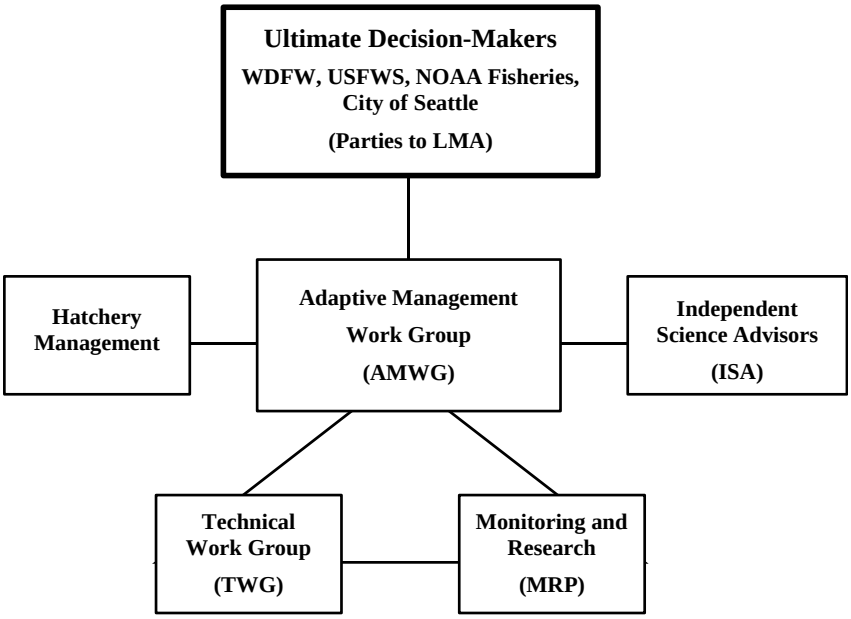
Administration of the AMP will require decision-making on a range of issues, including allocating funding for research and monitoring; setting annual production levels; and changing hatchery management protocols and operations, including ceasing hatchery operations, based on the results of monitoring and research activities. These decisions must be made with the best scientific advice and with a transparent process that seeks review from the scientific community, agencies, and the public. The AMP formalizes the decision-making process to involve appropriate groups in making recommendations to the Parties to the LMA.

In accordance with the Cedar HCP and the LMA, the AMP will place ultimate decision-making authority in the hands of the Parties to the LMA (WDFW, USFWS, NOAA Fisheries, and City of Seattle). This means that the City of Seattle will not be the only entity responsible for making important decisions regarding hatchery operations. The other Parties to the LMA are the three principal federal and state resource agencies with legal responsibility and authority for protecting endangered species and fisheries and with knowledge, interest, and expertise regarding potential adverse impacts that may be attributable to hatchery operations. The Parties will exercise direct authority over hatchery management and operations. Should these Parties determine that hatchery operations are adversely affecting protected species or otherwise threatening the health of the ecosystem, they have the statutory and regulatory authority, in addition to the authority they wield as Parties to the LMA and decision-makers under the AMP, to take appropriate action to address those impacts (e.g., by imposing restrictions on hatchery operations or by shutting down the hatchery altogether).

2.7.2 Who advises the decision-makers?

The decision-making structure of the AMP is important in ensuring that the results of scientific studies and monitoring are properly reviewed and translated into appropriate management responses. While the Parties to the LMA (listed in Figure 2-1) are the ultimate decision-makers, they are supported by a number of groups so that sound science underlies the Parties' decisions. Figure 2-1 conceptually illustrates the interaction between the different groups involved in decision-making for the hatchery. These groups are described below.

Figure 2-1. Groups Involved in Decision-Making for Cedar River Sockeye Hatchery



The **Adaptive Management Work Group** (AMWG) will have the responsibility of recommending policies, programs, committee membership, the names of independent scientists, and budgets. Similar to the makeup of the Cedar River AFC, the AMWG will be made up of stakeholder and agency representatives who have an interest in the Cedar River Sockeye Hatchery program. Meetings of the AMWG will be open to the public. The AMWG may include other people, groups, or agencies as necessary to represent the range of interests and perspectives on this project. The development of recommendations would incorporate input from other groups.

The **Technical Work Group** (TWG) will be responsible for the use of sound science in the evaluation of the hatchery. The TWG will consist, at a minimum, of five experts in the following areas: pathology, genetics, Lake Washington ecology, sockeye salmon biology, and hatchery reform/operations. In addition to these five positions, two other at-large positions would be available if needed to provide for either appointment of a generalist, or for other technical specialists. These appointees would be selected by the Parties to the LMA in consultation with the Cedar River AMWG, based solely on the technical expertise needed and the commitment of candidates to sound resource stewardship. Recommendations from the TWG will be available to the public to review.

Independent Scientific Advisors (ISA) will serve as a review and recommending body for the AMWG and as an advisory body for the TWG. The ISA will make recommendations to resolve conflicts regarding technical, research, and management approaches. A list of advisors will be developed that includes specialists living in the Northwest who are not serving on the TWG and

who have the qualifications needed to review scientific and technical aspects of the AMP activities. Nominations for appointment to this group will also be solicited from the stakeholder groups and the public at large. Individuals such as college professors and scientists associated with state, federal, or tribal organizations or in private practice are anticipated to form the pool of specialists from which to recruit. The Parties to the LMA will select the names of the advisors, after soliciting advice from the AMWG. Products from the ISA will be available for public review.

Monitoring and Research Parties (MRP) would be composed of the individuals carrying out the research and monitoring activities. These individuals would be expected to publish their results in peer-reviewed literature and to provide interpretations of their findings in conferences and at meetings of AMP committees. Their functions would include: (1) taking input from the TWG, AMWG, and ISA in developing and implementing monitoring and research activities; (2) developing and implementing monitoring and research plans that respond to identified technical and management needs; (3) participating in review processes to ensure the quality and independence of the work; and (4) providing the results and data from their studies in a timely manner.

Hatchery Management consists of the managers who are responsible for the day-to-day operations of the hatchery. This group would focus on applying scientific knowledge to the operations and management of the hatchery through the guidance provided by the AMWG and Parties to the LMA. This entity would be responsible for implementing actions as directed by the AMWG and Parties to the LMA, for implementing activities under its own authority (personnel matters, cost savings management), and for developing recommendations regarding changes in operations, policy, or management actions to the AMWG. Annual management reports will be available for public review.

2.7.3 How will the Parties to the LMA ensure that the scientific information and the decision-making process are accessible to the public?

Public involvement plays a critical role in providing extended review of scientific findings and of recommendations made by the AMWG to the Parties to the LMA. The public will have access to information and recommendations, the opportunity to listen to committee deliberations, and the chance to provide comments to committees and decision-makers. A transparent, predictable, and reliable decision-making process will help to ensure that the AMP is effective and that the information collected is used by decision-makers to guide operational decisions. The AMP includes the following guiding principles to ensure that both the data collected and the decision-making process are accessible to the public:

- The design and results of monitoring and research programs should be independently reviewed by qualified peer reviewers.
- Interested parties would be provided access to available information as well as to the process for full and timely participation in proposals and recommendations.

- The Parties to the LMA will seek consensus opinions when evaluating the biological results and when decisions are made.
- If a consensus opinion cannot be reached in the technical groups or in the AMWG, then recommendations will include both the majority and minority opinions.

2.8 What are the limitations of the AMP?

The Parties to the LMA consider the AMP to be an effective tool to assist the Parties in achieving the dual objectives of promoting the recovery and enhancement of the Cedar River sockeye population while avoiding and minimizing adverse effects. However, decision-makers and the public should recognize that the AMP cannot guarantee that adverse effects will be detected or fairly attributed to the operations of the new hatchery. The use of adaptive management, in contrast to traditional mitigation approaches, is intended to directly address adverse impacts in the face of the uncertainties of a complex biological system. Still, there is no guarantee that adverse effects that could occur can be effectively reversed or otherwise ameliorated by adjustments to operations of the new hatchery. Hence, the option of ceasing operations of the hatchery must remain among the options available to the Parties to the LMA. Adaptive management is becoming widely recognized as an important part of natural resource management. The implementation of the Cedar River Sockeye Hatchery AMP is expected to be closely monitored by the federal, state, and local governments that are bound by legal agreements to implement it. The public will have access to information and the adaptive management process to allow them to monitor the project as well.

Chapter 3
Worst Case Analysis

3.1 Introduction

The November 12, 2003 decision by a City of Seattle Hearing Examiner directed that an SEIS be prepared to provide a worst case analysis for potential significant impacts from operation of the hatchery on native fish stock. The following areas were included in these analyses:

- Genetics, including straying, homogenization, and domestication;
- Predation;
- Competition with other species for food supply;
- Competition for spawning areas; and
- Superimposition of sockeye redds on Chinook redds.

The worst case analyses were developed from discussions among scientists at a workshop conducted in early 2004. Refer to Section 1.6.2 in Chapter 1 for a description of the workshop process. The workshop summaries are included as Appendix B of this ~~SEIS~~FSEIS.

This portion of the ~~SEIS~~FSEIS supplements the FEIS for the Cedar River Sockeye Hatchery Project (SPU, 2003) and does not repeat information included in the FEIS, except where such information is necessary to provide a context for new information presented in the ~~SEIS~~FSEIS. The remainder of this chapter is organized mainly in a question and answer format. For each topic identified by the Hearing Examiner for worst case analysis, the following questions are addressed:

- What parameters were used to evaluate worst case impacts?
- What worst case assumptions were used in the analysis?
- Why is this topic a concern for the project?
- What did the workshop participants conclude related to this topic?
- What is the likelihood that this worst case impact will occur?
- What is the potential magnitude of the worst case impact?
- What can be concluded about the worst case scenario?

Following the questions and answers, each section then addresses the primary areas of uncertainty related to the topic, followed by a discussion of how the Adaptive Management Plan (described in Chapter 2) may be applied to reduce or mitigate the potential worst case impact. The chapter concludes with a description of potential cumulative impacts.

3.2 Genetic Impacts (Straying, Homogenization, Domestication)

3.2.1 Context/Background of Potential Impacts

3.2.1.1 What parameters were used to evaluate worst case impacts related to genetics?

Before evaluating potential genetic impacts, the workshop participants identified what parameters (measurable outcomes) would be most appropriate to use as a measure of potential impacts. The group discussed several possible parameters, but after considering such factors as the size and structure of the Lake Washington sockeye salmon population, they determined that *fitness* and *genetic diversity* would be the most appropriate parameters to use in measuring genetic impacts. These parameters are defined below:

Reduction in reproductive fitness. The term fitness has many definitions. The workshop participants defined fitness as the ability of naturally spawning fish to produce offspring that survive to successfully reproduce. In the context of genetics, different traits are known to contribute to the overall fitness of a population. For example, traits such as the date of breeding and size of eggs can affect the survival of young salmon and are under partial genetic control. However, it is important to consider that many factors affect the production of offspring by salmon. Climate-related factors such as flooding, water temperature, and survival at sea can result in mortality that affects the total number of fish that return to spawn, and this affects the numbers of fry produced in the next generation. The density of spawning adults can also affect the production of juveniles. For the purpose of isolating potential worst case genetic impacts, fitness as applied in this context was defined by the workshop participants as being independent of these non-genetic environmental factors. The assumption was that if environmental factors could be controlled (at least in a statistical sense), observed declines in productivity over successive generations of fish (i.e., fitness) could reasonably be attributed to genetic factors. Specific experiments demonstrating such reduction in fitness have not been conducted for Lake Washington sockeye salmon, but this approach was assumed to be based on sound scientific principles.

As noted above, there are many sources of variation in survival in Lake Washington and the marine environments through which sockeye salmon migrate. Consequently, the workshop participants recommended using the per capita production of downstream-migrating fry as the index of fitness rather than returning adults. They assumed that the factors hypothesized to decrease the fitness of naturally spawning salmon would affect the production of fry per female.

Subsequent life history stages were believed to introduce more variation (hence hindering the detection of effects) but not to affect the fundamental productivity of the spawning adults. The workshop participants therefore recommended that fitness be quantified as the number of sockeye salmon fry produced, divided by the number of spawning adults, after adjustment for the effects of environmental and density-dependent factors shown to affect fry production. For example, a 10% reduction in fitness would be defined as a 10% reduction in the number of salmon produced per female sockeye salmon, after adjustment for the effects of environmental and density-dependent factors.

Reduction in genetic diversity. Unlike fitness, genetic diversity is not specifically a measure of reproductive success. Genetic diversity is a broader concept that describes the overall variation of genes that are possible within an entire population at a given time, commonly referred to as the "gene pool." The more genetic variation there is in a population, the better the chance that at least some individuals will have a trait that would allow them to survive and reproduce under a stressful condition in the future. Temperature increases as a result of climate change or the advent of new diseases are two examples of potential future stresses. The workshop participants agreed that reductions in genetic diversity do not necessarily mean that reductions in fitness will follow; in fact, under stable environmental conditions a population with less diversity might have greater overall fitness. There is no unequivocal link between genetic diversity and specific levels of fitness. However, genetic diversity was included in the worst case assessment because of the potential for future changes to the environment, and the belief by workshop participants that higher levels of genetic diversity will better equip the population as a whole to persist through such changes.

One way in which genetic diversity is estimated is through levels of variation in genes that are not known to be influenced by selection pressure. Many genes occur in a number of variant forms, and possession of one form or the other appears to confer neither advantage nor handicap under present conditions. Populations with high levels of variation in these "selectively neutral" traits are assumed to have higher levels of diversity in traits related to fitness as well. A decline in the level of variation in these genes might signal a decline in overall genetic diversity.[1]

The workshop participants identified that both of these parameters (reductions in fitness and genetic diversity) contain some uncertainty given our current understanding of genetics. However, the group concluded that the use of these parameters as indicators of potential impacts was valid based on sound scientific principles. The uncertainty related to these parameters is summarized in Section 3.2.5 and discussed in more detail in the workshop summary in Appendix B.

[1] Although the term "gene frequency" was used during the genetics workshop, for the purposes of this discussion, the more general term "genetic diversity" is used. See the workshop summary in Appendix B for additional details.

3.2.1.2 What assumptions were used in the worst case analysis of genetic impacts?

In addition to the general assumptions for worst case outlined in Chapter 1, Section 1.6.2, the following assumptions were used in the analysis of genetic impacts:

- Adult sockeye (broodstock) would be collected at a location as far downstream as possible on the lower Cedar River.
- Hatchery protocols will result in a running average of no more than 50% of the adults returning to spawn being of hatchery origin.
- No more than 50% of the total return of sockeye would be taken for hatchery broodstock, and at least 10% of the broodstock would be non-hatchery adults in any given year.
- The impacts of straying, homogenization, and domestication can each be evaluated using the same parameters: (1) fitness, and (2) genetic diversity.

The following "worst case" assumption was used for genetic impacts:

- The number of spawning sockeye might exceed the current escapement goal of 300,000 by 20% due to imprecision in managing harvest. This assumption was to establish a worst case for the number of adults returning to the Cedar River.

Additional assumptions specific to each of the genetics topics are provided in the following sections where applicable.

3.2.2 Worst Case Analysis for Straying

3.2.2.1 Why is straying a concern for this project?

Straying occurs when individual sockeye salmon returning from the ocean to spawn do not return to the stream or river in which they reared (their natal stream) but rather enter and spawn in a different stream, river, or other spawning area.

Sockeye in the Lake Washington basin spawn in discrete locations. These include the Cedar River, certain Lake Washington beaches, Bear Creek, Issaquah Creek, and other smaller tributaries. For example, a sockeye that was spawned in the Cedar River would be considered a stray if it returned not to the Cedar River but to Bear Creek to spawn. While most salmon return to spawn in their home streams, straying is a behavior that occurs naturally in salmon populations and is the mechanism that allows salmon to colonize new habitats.

Increased straying is sometimes attributed simply to hatchery production. However, the scientific evidence is equivocal on the subject of whether hatchery rearing per se increases the tendency of salmon to stray. It is known that straying is associated with specific practices used in releasing hatchery fish. Some hatchery management practices that can increase levels of

straying include releasing fish into streams from hatcheries that are not located in the same basin, or releasing them at times of the year that are not natural for that population or where adults have difficulty accessing home systems. For the proposed hatchery, release location, release timing, and access to spawning areas would not be expected to increase straying because of management protocols expected to be in place. Nevertheless, some straying of Cedar River sockeye including those from the hatchery would be expected because this is in the nature of all salmon.

Sockeye breeding in the Cedar River, in Bear Creek and other tributaries, and on the Lake Washington beaches exhibit different traits that may have evolved as a result of natural selection pressures within the distinct breeding subpopulations. These traits include differences in use of habitat, in the timing of spawning, hatching, and emergence, in fry size at emergence, and in body size and/or shape. Participants in the workshop noted that because of the relatively recent introduction of sockeye, this species may still be evolving toward a suite of locally adapted traits. For the purpose of the worst case evaluation, it was assumed that these differences do exist and are meaningful.

The NOAA Fisheries status review of sockeye (Gustafson et al., 1997) found that Bear Creek sockeye may represent an indigenous Lake Washington sockeye population (sockeye that occurred within the Lake Washington basin before the construction of the Hiram Chittenden Locks and the introduction of non-indigenous sockeye salmon). However, the definitive existence of such a population has not been established, and there have not been direct studies of the genetic similarities between Bear Creek sockeye and a potentially indigenous Lake Washington sockeye.

Some studies have found that sockeye in Bear Creek differ genetically from other Lake Washington sockeye. Historical references from the early 1900s report relatively large numbers of kokanee salmon in Bear Creek and reference an apparent lack of sockeye salmon. (Jordan and Starks, 1895; State Division of Fisheries Report, 1932; Royal and Seymour, 1940). Some research suggests that sockeye in the Cedar River, Issaquah Creek, and beach spawners may be more closely related to each other and to sockeye from populations that are known to have been introduced into the basin (notably Baker Lake, in the Skagit River system) than they are to Bear Creek sockeye (e.g., Hendry et al., 1996). However, Spies (2002) concluded that all sockeye populations in the Lake Washington basin are likely derived from Baker Lake stock.

Thus, there are differing scientific views on the origin and differences between sockeye populations in the Lake Washington basin. Even with this uncertainty as to the level of differentiation among various populations, it is likely that, over time, reproductive isolation would allow the populations to develop some genetic differences related to the traits that give them a reproductive advantage in each of these geographic areas.

An important factor related to straying is the relative size of the various subpopulations. Based on current population levels, Bear Creek and beach spawning adults represent a small component of the larger Lake Washington sockeye population, ranging from a low of approximately 1% in 1989 up to approximately 17% in 2000 for Bear Creek, and from a low of less than 1% in 1991 to approximately 3% for Lake Washington beach spawners. Accurate counts for Lake Washington beach spawners are not available (S. Foley, WDFW, personal communication,

2004). So, if even a relatively small proportion of Cedar River-origin fish strayed, they could represent a relatively large proportion of the total number of spawners in either of the smaller Bear Creek or beach spawning subpopulations.

Therefore, straying is a concern for this project for two main reasons:

First, the Bear Creek sockeye might represent a distinct subpopulation within the Lake Washington basin. This is important because NOAA Fisheries provisionally determined the Bear Creek population to be distinct for purposes of Endangered Species Act protection, although it is not believed to be presently in danger of extinction and not likely to become endangered in the foreseeable future if present conditions continue (Federal Register, Vol. 63, No. 46, pp. 11749-11771). The beach spawning sockeye are apparently of non-native origin and genetically similar to Cedar River-origin sockeye; however, they exhibit physical and behavioral traits that indicate they are diverging into a unique subpopulation. Sockeye in Bear Creek are presumably better suited to spawning and incubation conditions in Bear Creek, and sockeye from the beach spawning subpopulation are presumably better suited to spawning and incubation in habitats along the Lake Washington shoreline. Cedar River sockeye presumably are less suited for breeding in other streams (such as Bear Creek) or on the beaches of Lake Washington. Therefore, significant straying of sockeye from the Cedar River that results in interbreeding could reduce the fitness of sockeye in the Bear Creek or beach spawning subpopulations. This reduction in fitness does not specifically depend on changes in the Cedar River population that might arise from the hatchery (though such changes might exacerbate the matter). Rather, the basic concern is that the Cedar River fish are presumably better adapted for the Cedar River than they are for Bear Creek, and so by breeding in Bear Creek or by interbreeding with Bear Creek fish they would reduce the average fitness of fish in Bear Creek.

A reduction in fitness could occur in a variety of ways. For example, Cedar River female sockeye are generally larger than Bear Creek female sockeye (Hendry and Quinn, 1997). One hypothesis is that in the Cedar River, larger body size may be an advantage in being able to build a nest in the larger substrates of the river bottom. This same trait of larger size could be a disadvantage in Bear Creek because it may reduce access to suitable spawning areas or increase mortality as a result of stranding in the shallower water of the smaller stream.

Second, straying of sockeye from the Cedar River could also reduce the genetic diversity of subpopulations in other Lake Washington tributary streams or beaches. Hypothetically, rampant straying might cause all subpopulations within the basin to be genetically similar, and the loss of diversity within any component might reduce the capacity of that component (hence the system as a whole) to resist some environmental adversity in the future. As stated earlier, genetic diversity may not be directly related to fitness. However, genetic diversity may affect the ability of a population to adapt to future challenges, such as new diseases or changes in climate. Genetic variation improves the chance that at least some individuals will be able to survive and reproduce under future conditions. For example, Bear Creek fish may have genes that result in a trait that does not provide a specific benefit at this time, but may be beneficial at some time in the future. The presumption is that genes introduced from straying Cedar River-origin adults that interbreed with Bear Creek-origin adults or beach spawning adults could result in offspring that are genetically more similar to their Cedar River parents than their Bear Creek or beach

spawning parents. This decrease in diversity could, someday, manifest itself in a reduced ability of the Bear Creek or beach spawning sockeye subpopulation to respond to some future environmental challenge.

There is a paradox surrounding the effects of straying between populations. The more distinct the populations are in their adaptive traits, the more we might worry about the consequences of straying. However, the more distinct the populations, the less likely it is for strays to successfully reproduce, and indeed straying may be less common between more discrete populations, so in this way straying is less likely to affect the genetic makeup of the populations.

3.2.2.2 What did the workshop participants conclude related to straying?

The workshop participants reached several key conclusions related to the worst case analysis for straying (below). See the workshop summaries in Appendix B for additional details.

Rates of straying from the Cedar River to Bear Creek under the operation of the interim sockeye salmon hatchery are low. Some level of straying is expected in salmon populations. However, evidence indicates that the rates of straying by hatchery-produced fish from the Cedar River to Bear Creek (and by extension, other tributaries at the north end of the lake) are very low. WDFW examined otoliths from 1,219 Bear Creek sockeye salmon from 1998, 1999, and 2000 and did not find a single fish with the distinctive marking patterns that would have identified it as a hatchery fish from the Cedar River (Fresh et al., 2001). The marking technique and ability to detect marks are not in question, so the conclusion is that Cedar River hatchery fish must have composed, at most, a very small proportion of the spawners in Bear Creek in those years. The workshop participants felt that a few strays may have been missed by chance, so the true level of straying from the Cedar River to Bear Creek was not assumed to be zero for worst case conditions, but it is probably on the order of 1% or less.

On average, the Cedar River produces about 10 times as many adult sockeye salmon as does Bear Creek. Thus if 1% of the Cedar River sockeye strayed, they would constitute on the order of 10% of the sockeye in Bear Creek. Such straying levels, if they were occurring, would likely have resulted in recovery of marked hatchery strays. After the workshop concluded, a more extensive evaluation was conducted by Dr. Thomas Quinn, based on WDFW data provided by Steve Foley to SPU including counts of adult salmon in the Cedar River and Bear Creek. Dr. Quinn attempted to refine the estimate of the straying rate of sockeye salmon from the Cedar River into Bear Creek based on monitoring results. Dr. Quinn's analysis of this issue, included in Appendix B, determined that a straying rate of up to 0.2% is appropriate, based on evaluation of the estimated survival rate of hatchery fish and observed straying in Bear Creek.

Rates of straying to beaches may be higher. A higher rate of sockeye straying is anticipated from the Cedar River to the Lake Washington beaches because the beaches are closer to the mouth of the river. Examination of natural variation in otolith banding patterns (which is less reliable than use of marked otoliths for determining the origin of individual fish) by Quinn et al. (1999) revealed fish on the Pleasure Point beach that had apparently strayed from the Cedar River. However, the authors did not quantify the proportion of Cedar River fish that these apparent strays might have constituted. In addition, the beach subpopulations have fewer

spawners than Bear Creek (in recent years), so a given percent of strays from the Cedar River would constitute a higher percent of the fish in the beach subpopulation than it would in the Bear Creek subpopulation.

Hatchery-produced sockeye salmon might have a greater tendency to stray than naturally produced Cedar River sockeye salmon, though data are mixed. Limited data are available, but study results do not agree about the effects of routine hatchery practices on straying. McIsaac (1990) concluded that hatchery practices increased straying by Lewis River Chinook salmon, whereas Labelle (1992) concluded that straying of coho did not increase as a result of hatchery practices on Vancouver Island. Off-site releases can increase straying behavior (Quinn 1993), and abnormal timing of release (i.e., at an unnatural time of the year) can also elevate straying (e.g., Unwin and Quinn 1993). Thus, increased straying rates may be attributed to specific hatchery practices but it is unclear whether hatchery rearing necessarily increases straying. An increased tendency of hatchery-produced fish to stray has not been demonstrated during the operation of the interim hatchery (Fresh et al., 2001). However, it is unknown if the tendency to stray could change under the proposed hatchery management plan because the proposed hatchery will have facilities for short-term rearing, and both broodstock collection and hatchery release practices will be somewhat different than they are with the current interim hatchery. The workshop participants also discussed the possibility that future, currently unplanned hatchery management decisions could increase straying rates. Particularly, if sockeye fry from the hatchery are released at or near the mouth of the Cedar River, returning adults might be more likely to stray because they may not imprint strongly enough on the Cedar River to return there to spawn. Because of these uncertainties, a rate of straying above the 0% observed by Fresh et al. (2001) was assumed to be likely under the worst case scenario.

Greater numbers of returning sockeye could increase the total numbers of straying fish. Straying could increase as a result of higher numbers of adult spawners resulting from the proposed hatchery. While the intent is that increased numbers of returning adults would be offset by higher numbers taken by the recreational and tribal fisheries in Lake Washington, the assumption under the worst case scenario is that 20% more adults could return above current escapement goals. Assuming that the straying rate is not density-dependent (that is, the overall rate of straying remains constant as the total numbers of spawning sockeye salmon in the Cedar River increase as a result of hatchery production), and accounting for the worst case assumption that straying rates from the Cedar River to Bear Creek could be as high as 0.2%, the overall total number of strays could increase simply as a result of having more fish in the system.

3.2.2.3 What is the likelihood that straying will occur?

There are no data to suggest that Cedar River hatchery returns stray into Bear Creek. However, as stated above, the level of straying from the Cedar River to Bear Creek may not be zero but statistical analysis suggests that, at worst, it is probably not greater than 0.2% under existing conditions. Rates of straying to Lake Washington beaches may be higher than in Bear Creek. The workshop participants concluded that the total number of straying fish may increase as a result of increased adult returns to the river. The workshop participants also identified the potential that increased rates of straying could occur in the future as a result of management decisions that deviate from current planned operations. Therefore, the consensus among the

workshop participants was that, under the worst case assumptions, an increased number of strays between the Cedar River and Bear Creek and/or the beach spawning subpopulations has a high likelihood of occurring as a result of the proposed sockeye salmon hatchery.

3.2.2.4 What is the potential magnitude of impact from straying?

The following sections address the magnitude of worst case impacts resulting from straying to Bear Creek and to Lake Washington beaches. The discussion addresses the number of strays, impacts to fitness, and impacts to genetic diversity for these two subpopulations of sockeye. The workshop participants expressed a range of opinions about the potential magnitude of impacts. There was a greater range of opinions expressed about the potential magnitude of impacts from straying compared with the opinions relative to the likelihood that straying would occur. The potential impacts to fitness were defined as potential percentages of fitness reduction (i.e., reductions in the future production of offspring by naturally spawning salmon). Because of the range of opinions expressed by the workshop participants, the results are expressed as the median of the values identified by the participants, and the extremes on both ends of the spectrum are indicated. Because these values are shown as medians, they do not necessarily add up to 100%. Medians were reported rather than means because the values were not normally distributed (i.e., not the classic "bell-shaped," symmetrical distribution).

Overall, the level of concern about straying from the Cedar River hatchery into tributary populations in the basin was low. The lack of concern stemmed mainly from (1) the empirical evidence from WDFW research indicating an exceedingly low occurrence of strays into Bear Creek (undetected in 1,219 fish examined), (2) the geographical isolation of the Cedar River from the other main spawning sites, (3) a sense that significant straying by sockeye salmon is generally uncommon, and (4) a sense that a low level of straying occurs naturally and probably causes little or no harm.

3.2.2.5 Bear Creek Subpopulation

Number of strays. The workshop group concluded that some straying of sockeye to Bear Creek occurs at low levels (up to 1%) based on current data and general assumptions about the role of straying in salmon life histories. Further analysis done for this worst case analysis refined this estimate to 0.2% or less (Appendix B). Assuming an adult sockeye return to the Lake Washington basin of 360,000[2] adults (mixed hatchery and naturally spawned), a 0.2% rate of straying would result in up to 720 strays from the Cedar River annually. Using a worst case assumption that all of these strays move to Bear Creek and that they all are of hatchery origin, this would result in 720 total Cedar River strays per year entering Bear Creek. Based on an average of 17,600 adult sockeye returning to Bear Creek each year (average 1982 to 2000; WDFW unpublished data), a 0.2% stray rate of Cedar River sockeye would therefore result in strays composing 4.1% of the Bear Creek sockeye subpopulation annually. However, it is likely

[2] This number is based on the worst case assumption that returns could be 20% higher than anticipated due to imprecision in managing harvest. See Section 3.2.1.2.

that only a portion of these strays would actually be hatchery-origin strays, and only a portion of those would be a result of increased hatchery production. Some of these strays would likely come from naturally produced sockeye and some would come from the level of hatchery production that currently exists.

Impacts to fitness. The workshop participants concluded that a level of straying up to 1% would be anticipated to result in a high likelihood (median value of 95% chance of occurrence) that the Bear Creek sockeye subpopulation would experience less than a 10% drop in reproductive fitness over the 50-year assessment period. (The more refined worst case assumption of 0.2% Cedar River strays, even assuming all strays are from the hatchery, would likely result in a substantially lower level of impact.) The chance of a 10 to 20% reduction in fitness was estimated by the workshop participants at a median value of 5%. The estimates made by the individual workshop participants varied, depending upon the assumptions made, but five of the six scientists performing the evaluation noted that there was at least a 90% probability that the reduction in fitness would be between zero and 10%. The sixth scientist expressed a higher level of concern; however, he assumed that releases would be made to the lower river or the mouth of the river, and that the straying rate from the Cedar River would increase to 5% to 10% of the population within 5 to 10 generations.

Impacts to genetic diversity. A straying level of up to 1% was anticipated to result in a high likelihood (estimated at a median 90% chance of occurrence) that the Bear Creek sockeye subpopulation would experience less than a 10% reduction in genetic diversity. The chance of a 10% to 20% reduction in genetic diversity was estimated at a median value of 8%; the chance of a 20% to 30% reduction was estimated at a median value of 5%. These estimates do not indicate that equivalent reductions in fitness would follow, given that there is no unequivocal link between measures of genetic diversity and quantifiable measures of fitness such as number of offspring.

3.2.2.6 What can be concluded about the impact to the naturally spawning Bear Creek sockeye subpopulation from straying?

Under the worst case assumptions, the workshop panel estimated that straying from the Cedar River is likely to result in a small reduction of fitness and genetic diversity within the Bear Creek sockeye subpopulation. However, this reduction is not anticipated to result in the loss of this group as a distinct subpopulation. This conclusion is based on the following factors:

- Empirical evidence shows that straying from the interim Cedar River hatchery has been low (Fresh et al., 2001).
- Low levels of straying are assumed to occur naturally in these populations.
- The new hatchery is not anticipated to result in higher straying rates than those that occur with operation of the interim hatchery if the new hatchery follows proposed operating protocols.
- Some increase in the number of strays as a result of increased numbers of fish from the Cedar River would likely occur regardless of whether the fish were from a

hatchery or naturally produced. Increases in quality habitat (resulting from Cedar HCP investments and investments by others) and higher hatchery returns are expected to contribute to increased numbers of naturally spawning sockeye, and thus more strays.

- While it is likely that, under worst case assumptions, there will be some decrease in fitness and genetic diversity in the Bear Creek subpopulation, there is only a small chance that it would be significant. The more significant the differences between Bear Creek and Cedar River fish, the more resistant the Bear Creek population will be to influence by strays.

In summary, there is a high probability that a minimal level of straying will occur, and indeed such straying is probably occurring at present, as it is assumed to be common among salmon populations. However, even under worst case assumptions, the anticipated rate is so low that the probability of a negative impact is low over the 50-year life of the hatchery project. Therefore, both the probability of a significant increase in occurrence and level of impact are considered to be low. Some scientists in the workshop group expressed concern about the potential for impacts beyond 50 years. It is difficult to project the impact of straying relative to other factors, such as watershed development, global warming, and others. Therefore, this worst case analysis is limited to the anticipated design-life of the facility.

3.2.2.7 Beach Spawning Subpopulation

As stated earlier, a higher rate of straying to beach spawning areas from the Cedar River is anticipated because the beaches are closer to the river mouth than is Bear Creek. Also, impacts to sockeye fitness and genetic diversity are anticipated to be higher for the beach subpopulation because of its smaller size and because beach spawning fish appear to have more adaptive traits that affect their fitness. Beach spawners tend to spawn later than most river spawners, and they differ in average size and shape. These traits may be linked to fitness relative to environmental factors within the beach spawning subpopulation that are not present in other populations.

Number of strays. There are no data to support specific straying rates from the hatchery into Lake Washington beach sites. Quinn et al. (1999) provided evidence for straying to Lake Washington beaches but did not establish a straying rate. The assumption under the worst case scenario is that straying of sockeye to spawning beaches currently occurs and that the rate of straying is currently higher than that to Bear Creek, because the beach is closer to the Cedar River. It is also assumed under the worst case scenario that beach spawners would experience a higher total number of strays if straying were to increase as a result of density-dependent or density-independent factors in the Cedar River. Moreover, the beach spawning population is presently smaller than that in Bear Creek, so a similar number of strays would constitute a larger percentage of the beach subpopulation (hence perhaps a larger effect) than it would in Bear Creek. Information on abundance of lake spawners is of limited accuracy; however, previous WDFW estimates have indicated that between 1982 and 2000, beach spawners represented 1.7% of the total sockeye in the Lake Washington basin (range 0.6% to 5.1%). Beach spawners are thought to currently represent a small fraction of the sockeye returns each year. (S. Foley, WDFW, personal communication.)

However, it is also possible that the number of strays actually spawning on the lake beaches would not increase in proportion to the increase in the total number of strays because the lake beaches provide a much different spawning habitat than Cedar River fish have become adapted to exploit. Because of habitat differences, not all fish that stray to the lake beaches necessarily spawn there. Because of the high level of uncertainty, the scientists at the workshop did not predict a specific rate of straying to beach spawning areas. There is insufficient information to estimate the straying levels as was done for Bear Creek.

Impacts to fitness. The estimates of the effects of straying on the beach subpopulation were more varied among the scientists than were the estimates of effects on Bear Creek. Considering that there was more uncertainty around the total number of strays to the beach spawning subpopulation, and other factors, the workshop group concluded that, under worst case assumptions, there could be a 50% chance that the beach spawning subpopulation would experience less than a 10% reduction in fitness. The chance of a 10% to 20% reduction in fitness was estimated at 30%; the chance of a 20% to 30% reduction in fitness was estimated at 20%. Individual scientists rated the potential reduction as being higher than 30%. There was some discussion that the beach subpopulation may be at a higher risk of extinction from factors unrelated to the proposed hatchery, such as shoreline habitat modification and existing levels of fishing, and may also be at risk from hatchery-related processes other than genetics (notably increased fishing pressure in Lake Washington as a result of the anticipated increase in the number of adult returns).

Impacts to genetic diversity. Straying was anticipated to result in a 35% chance that the beach spawning subpopulation would experience less than a 10% reduction in genetic diversity. The chance of a 10% to 20% reduction in genetic diversity was estimated at 20%; the chance of a 20% to 30% reduction was estimated at 14%; the chance of a 30% to 40% reduction was estimated at 6%; the chance of a 40% to 50% reduction was estimated at 3%; and the chance of a 50% to 60% reduction was estimated at 1%. Similar to the estimates for loss of fitness, there was considerable variability among the scientists regarding the effects of straying on genetic diversity in the beach subpopulation.

3.2.2.8 What can be concluded about the impact of straying upon the beach spawning subpopulation in Lake Washington?

Under worst case assumptions, straying from the Cedar River to the beach spawning subpopulation is likely to result in a reduction of fitness and genetic diversity within the beach spawning subpopulation. The impact of straying on the beach spawning sockeye is anticipated to be greater than on the Bear Creek sockeye. The assumption is that because of the small size of the beach subpopulation and its proximity to the Cedar River, it would be more susceptible to straying impacts since even a small number of strays from the Cedar River could represent a higher percentage of the adult spawners at the beach. Also, because there are fewer individuals in the beach subpopulation, even small reductions in fitness over successive generations could result in a decline. It is not likely that the beach subpopulation would be driven to extinction as a result of genetic impacts to fitness within the 50-year time period of this assessment; however, it is possible that reductions in fitness could result in a population that could not sustain itself over a longer term. While there may still continue to be fish present in beach habitats as a result of

straying from the Cedar River stock or other populations, there is greater risk that the project could contribute to the loss of the beach spawning sockeye as a reproducing, distinct subpopulation under the worse case scenario. This conclusion is based on the following factors:

- The likelihood of straying is higher for the beach subpopulation because of the proximity of the beach spawning sites to the mouth of the Cedar River.
- The beach spawning subpopulation is smaller than the Bear Creek subpopulation, so even a few strays would likely result in a larger impact.
- Since the introduction of Baker Lake sockeye, beach spawning sockeye appear to have developed specific traits that differ from Cedar River sockeye. These traits may favor reproductive fitness for the unique spawning habitat on the beaches. As a result, the offspring of beach spawners are more likely to have a greater reduction in fitness and genetic diversity as a result of interbreeding with sockeye straying from the Cedar River.

The estimates of the effects of straying on the beach subpopulation were much less consistent among the scientists than were the estimates for effects on Bear Creek. Some of the scientists did not think that this subpopulation was vulnerable, some felt it was at risk from the effects of Cedar River strays, while others felt it was significantly at risk from factors unrelated to the hatchery such as shoreline and habitat degradation.

When considering long-term impacts to the beach spawning subpopulation, the scientists pointed out that it is also important to consider:

- Impacts to the beach spawning subpopulation may be inevitable if the Cedar River produces more sockeye, regardless of whether these additional sockeye are from a hatchery or naturally spawned.
- It is likely that there will be a decrease in fitness and genetic diversity, but a relatively small chance that this reduction could be significant to the overall sockeye population in the Lake Washington basin, even though it may be significant to beach spawners.
- Beach spawners were probably derived from the same parental stock as Cedar River sockeye, and differences have evolved relatively recently in terms of evolutionary time (since the late 1930s or 1940s).
- The beach spawning subpopulation has apparently been able to diverge from the Cedar River sockeye population and to maintain itself despite relatively high sockeye return levels to the Cedar River that occurred historically, and despite the straying that would have occurred at these levels.
- Other factors, particularly fishing pressure and impacts to habitat from shoreline development, may be more immediate threats to beach spawning sockeye than potential genetic impacts from hatchery fish. However, it is important to note that the existing beach spawning subpopulation has maintained itself during the operation of the interim hatchery that has produced returns since 1995.

In summary, the probability of straying to Lake Washington beaches, under the worst case assumptions, is low to medium, but the level of impact may be medium to high for the Lake Washington beach spawning subpopulation.

3.2.3 Worst Case Analysis for Homogenization

3.2.3.1 Why is homogenization a concern for this project?

Homogenization occurs when individuals from one subpopulation or reproductively isolated group interbreed with other groups to the extent that adaptive traits of the previously isolated groups are compromised. The effects of homogenization are similar to the effects of straying, but they may occur within the various subpopulations or distinct reproducing groups of a single river or stream system (such as the Cedar River) rather than being spread across an entire basin (such as the Lake Washington basin). Homogenization is a concern in those systems where reproductively isolated subpopulations exist. It is not known whether or not the Cedar River has such subpopulations. However, Fresh et al. (2003) found that hatchery returns differed in their spatial distribution within the river compared to natural origin spawners.

As with straying, some degree of interbreeding between subpopulations is expected as a natural process. When hatchery returns interbreed with naturally produced fish, the genetic structure of naturally occurring subpopulations that may exist within a river can be modified. Homogenization can result from hatchery-produced fish interbreeding with naturally produced fish, or naturally produced fish from different subpopulations interbreeding with each other. This may occur either as a result of broodstock collection practices (where both hatchery and naturally produced fish from a variety of subpopulations are all collected and spawned together) or as a result of hatchery-origin fish being allowed to reproduce naturally in the river where they could interbreed with naturally produced fish. Within this context, homogenization would occur if, for example, sockeye destined to spawn in a tributary of the Cedar River were bred in the hatchery and so were lost to the tributary subpopulation, and fish from different reaches of the Cedar River were bred together although under natural conditions they would have segregated. The result could be the loss over time of traits that distinguish groups of naturally produced fish as unique subpopulations within the river.

Homogenization is therefore a concern for this project because:

- If Cedar River sockeye salmon are currently composed of several distinct subpopulations, sockeye within each subpopulation would have traits that presumably allow those fish to have higher fitness relative to their specific spawning and rearing environments than fish from other subpopulations. Interbreeding between fish from distinct subpopulations or breeding hatchery returns with natural returns could reduce the fitness of the overall Cedar River sockeye population.
- As with straying, homogenization could reduce the genetic differences between potential subpopulations within the Cedar River as a result of the interbreeding between hatchery-produced and naturally produced sockeye, and between naturally

produced sockeye from different subpopulations. Over time, this could result in the loss of genes that could provide higher levels of fitness in the event of some future environmental change.

- Even if the current population of sockeye in the Cedar River lacks distinct subpopulations or other distinct reproductive groups with traits that increase their fitness, the project, which does assume interbreeding between hatchery and naturally spawning sockeye both in the hatchery and on the spawning grounds, could reduce the tendency of the population to develop genetically distinct subgroups in the future.

3.2.3.2 What did the workshop participants conclude related to homogenization?

The workshop participants reached several key conclusions related to the worst case analysis for homogenization (below). See the workshop summaries in Appendix B for additional details.

Information that would show whether distinct spawning subpopulations have actually formed in the Cedar River is mixed. Observations that support the existence of a relatively complex population structure in the Cedar River include:

- Spawning sockeye in the Cedar River vary in how they are distributed over space and time. Early returning sockeye seem to spawn mainly in the upper reaches of the river, while later returning sockeye tend to spawn in the lower reaches. There is, however, overlap in spawning times and locations. Some off-channel spawning areas are used significantly later in the season than the population as a whole, though again there is overlap. As specific examples, peak spawning throughout the river mainstem occurs in late September through November. Peak spawning occurs in Wetland 79 (an off-channel site located 28 km upriver from Lake Washington) in late November through early December. Spawning peaks in Cavanaugh Pond (located 10 km upriver from Lake Washington) in December and January (Hall and Wissmar, 2004).
- One preliminary study concluded that there could be genetic differences between early and late spawners in the Cedar River (Bentzen and Spies, 2000).
- WDFW data show that adult sockeye tend to return to the reaches of the river where they were released as fry instead of randomly redistributing throughout the river system. (Schroder, personal communication, 2004).

On the other hand, factors that point to a Cedar River sockeye population that is currently more homogenous include:

- The entire population of sockeye in the Cedar River is apparently the result of stocking in the 1930s. This recent origin might argue against the development of a complex population structure.
- Patterns of spatial and temporal habitat use may be attributed to non-genetic factors such as access to spawning areas, temperatures, or density of spawning sockeye.

- A relatively low proportion (estimated at 5% to 10%) of sockeye returning to the Cedar River are thought to spawn in tributaries, side channels, or other areas outside of the main river channel. The numerical dominance of the mainstem Cedar River subpopulation means that if even a small proportion of mainstem spawners stray into tributaries or side channels, these strays would represent a high proportion of spawners in the tributaries. This high proportion of mainstem strays would reduce the tendency for local adaptations to evolve in tributaries and side channels.
- There is evidence of sockeye colonizing new spawning areas within the river. For example, sockeye used a new spawning channel constructed in Ron Regis Park at high densities the first year the channel was available. This suggests that the sockeye have less fidelity to natal areas and spawn more opportunistically than would be the case if there were subpopulations that had evolved to spawn only in specific areas.
- Hundreds of natural-origin sockeye were collected in the fish ladder at Landsburg during the first season of the operation of the fish passage facilities (2003). These fish were trying to migrate above the dam and most would likely have spawned there, if given the opportunity to do so, based on observations of the behavior of coho and Chinook. This may provide evidence that some number of sockeye in the Cedar River do not return to their natal areas to spawn, since the area above the fish ladder was not previously available for spawning. The hypothesis is that a strong tendency to return to natal areas would be necessary for the development of distinct subpopulations within the river. Since this does not appear to be the case, the Cedar River population presently may have a tendency to be spatially homogenous.

The workshop group concluded that whether or not a complex population structure exists in the river now, over time it would tend to evolve without other intervention.

Homogenization could occur through two main mechanisms of impact. First, an increased number of hatchery-produced fish returning to the Cedar River system would increase the likelihood of hatchery-produced fish spawning with naturally produced fish. Second, the methods used to collect broodstock for the hatchery and to release juveniles could result in homogenization. Specifically:

- Adults that would otherwise be reproductively isolated in different parts of the river could be collected together at the single broodstock collection weir and then be interbred at the hatchery. The one fixed weir location is downstream of most sockeye spawning activity. This would increase the likelihood that individuals from distinct spatial spawning subpopulations would be collected and bred together. Distinct temporal subpopulations would still tend to remain segregated.
- Juvenile fish would be released within the river at various locations regardless of where they would have naturally emerged had their parents returned to their natal areas to spawn. This could result in an individual sockeye with traits that might favor survival in a particular reach or tributary returning to spawn instead in a different part of the river system where its traits do not increase its fitness.

3.2.3.3 What additional assumptions were used in the worst case analysis of homogenization?

Additional worst case assumptions used in the analysis for homogenization include:

- The workshop participants did not come to a conclusion about whether distinct subpopulations of sockeye currently exist in the Cedar River. For the purpose of the worst case assessment, the workshop group assumed that some degree of complex population structure occurs in the Cedar River, and subpopulations have developed that have traits that increase their fitness.
- Regardless of whether or not there are distinct subpopulations now, over time and in the absence of a hatchery, sockeye in the Cedar River could segregate into distinct subpopulations with specific genetically related traits that would increase their fitness.

In addition, the following general assumptions were important to the worst case analysis:

- Harvest rates for hatchery and natural-origin sockeye are roughly equal.
- The collection facility would collect proportions of hatchery-produced and naturally produced broodstock that are consistent with those in the overall return.

3.2.3.4 What is the likelihood that homogenization will occur?

Homogenization has a high possibility of occurring under the worst case scenario. The goal for the management of this hatchery differs from many other hatcheries. The proposed hatchery would be managed to maximize the mixing of hatchery-produced and naturally produced fish each year to the extent possible through the design of the broodstock collection program. A fundamental goal of the proposed hatchery program is to produce an integrated run in the Cedar River. This is consistent with the principles and recommendations of the Hatchery Scientific Review Group (HSRG, 2004). To achieve this goal, the hatchery would collect both naturally produced and hatchery-produced adults at the downstream weir. Because it will not be possible to discriminate between hatchery-produced fish and naturally produced fish before spawning (since identification requires dissection of the fish), this will result in the random interbreeding of fish based on origin. It is inevitable that some hatchery fish will be bred with naturally produced fish, and interbreeding of naturally produced fish that originated from tributaries or distinctly different portions of the river will also occur. This is in contrast to the management at many other hatcheries that has resulted in a segregated run where the goal is to develop and maintain separation between hatchery and naturally produced stocks.

In addition, hatchery fry will be released at various points within the river so that they will tend to return to those portions of river to spawn and approximate the natural spawning distribution throughout the river. These practices have been intentionally proposed to produce an integrated run in the Cedar River; however, they also promote homogeneity within the overall population.

3.2.3.5 What is the potential magnitude of the worst case impact for homogenization?

The magnitude of the worst case impact is discussed below in terms of the impacts to fitness and genetic diversity.

Impacts to fitness. There was debate among the scientists at the workshop about whether a complex sockeye population structure currently exists in the Cedar River, and how much biological significance it has (whether the population expresses a range of traits due to reproductive isolation that increases fitness for members of those isolated groups). The general consensus was that because of the relatively short timeframe that this stock of sockeye has existed in the Cedar River (approximately 70 years), distinct subpopulations have not had time to develop; however, there are no specific data available to confirm this.

The discussion concluded that there is a 60% chance (median value) that homogenization would result in less than a 10% reduction in fitness. The chance of a 10% to 20% reduction in fitness was estimated at a median value of approximately 30%, and the chance of a 20% to 30% reduction was estimated at a median value of 10%. There was some variation among individual scientists about the anticipated impact and the assumptions used. Estimates varied depending upon factors such as where the adult collection site and fry release points would be located.

Impacts to genetic diversity. The workshop group estimated median values of a 10% chance of less than a 10% reduction in genetic diversity; a 15% chance of a 10% to 20% reduction in diversity; and a 10% chance of a 20% to 30% reduction in genetic diversity. The variation among the five participating scientists in their assessment of impacts to genetic diversity was higher than the variation on any of the other workshop topics. This was primarily a result of differences in opinion relative to the likelihood that a complex population structure currently exists, or could develop, within the Cedar River. The workshop participants also varied on what specific assumptions were key to the analysis. One scientist estimated a very low potential that an effect would be observed based on his assumption that there is little, if any, existing population structure. However, this scientist estimated that the proposed project would be highly likely to have a small effect if a diverse population structure did exist (one of the worst case scenario assumptions). Another scientist predicted a low level of effect but noted that homogenization would likely occur over the next 50 years (about 12 generations). One scientist felt that genetic diversity among possible subpopulations within the Cedar River would decrease substantially (70% to 80%) as a result of hatchery operations, but that the impact to the fitness of the population as a whole would be very low because the level of genetic differentiation is low.

3.2.3.6 What can be concluded about impacts to the naturally spawning Cedar River sockeye population from homogenization?

Using the worst case scenario assumption that a complex population structure exists and it has a positive influence on the fitness of the larger sockeye salmon population within the Cedar River, there is a high probability that some level of homogenization would occur as a result of hatchery operations, and that there would be a low level of reduction in fitness of the Cedar River sockeye population as a result. The workshop group felt that there is a 90% chance of a reduction in

fitness of less than 20%, and a 10% chance that the reduction in fitness could range between 20% and 30%. There was no clear consensus among the workshop group about the potential impacts to genetic diversity from homogenization resulting from hatchery operations. Under a worst case outcome, there would be complete homogeneity within the Cedar River sockeye population, with no discernable subpopulations of adult spawners. The result would be the elimination of genetically different subpopulations within the Cedar River assuming that they currently exist. While this was anticipated to result in a moderate to low (less than 20%) reduction in overall fitness, it could reduce the ability of the Cedar River population to react to future changes in environmental conditions. The group reflected much more uncertainty in the assessment of the likely reduction in genetic diversity. There was really no consensus within the group as to this effect.

Since the Worst Case Analysis Workshop was held, WDFW released the final report by Fresh et al. (2003) that included information comparing hatchery and natural origin Cedar River sockeye during the period of 1995-2000. The authors found several differences between hatchery and natural origin sockeye, including differences in the size of females of the same age, spatial spawning distribution, and the timing of broodstock collection relative to overall run timing. No differences were found between hatchery and natural origin returns in age at maturity or run timing. Differences in spatial distribution would likely contribute to homogenization by changing where sockeye would have otherwise spawned. While the authors propose ways of addressing these spatial differences between hatchery and natural origin returns, it is not certain how effective these changes would be or if they are feasible. Since the number of fry produced per natural spawner from the study years was at or above pre-hatchery return levels, the findings in the Fresh et al. (2003) report do not change the conclusion that homogenization is likely, but that the impact on fitness would likely be moderate to low. This issue will continue to be monitored through the Adaptive Management Plan.

3.2.4 Worst Case Analysis for Domestication

3.2.4.1 Why is domestication a concern for this project?

Domestication occurs when hatchery operations or management decisions result in the production of fish that have traits that make them more adapted to a hatchery environment, but less adapted to the natural environment. This is because there are different selection pressures in the hatchery environment versus the natural environment. For instance, in a traditional hatchery where the fry are fed and released after they have grown considerably, they may become used to going to the surface to find food that has been thrown in to them rather than feeding further down in the water column. Those that orient to the surface may grow larger than those that do not. Ultimately, if this trait is at least partly hereditary, the survival rate of juveniles from hatchery parents would be reduced in the natural environment because such behavior would make them more vulnerable to predators. These same fish may have a more difficult time foraging for food on their own once they are released into the river.

However, it is important to realize that there are two types of factors affecting domestication that are often confused: (1) inherent and unavoidable factors associated with artificial production, and (2) management decisions that are made in artificial production programs.

Hatchery production has intrinsic effects on the genetics of fish produced in the facility. These effects occur as a result of removing selection pressures during the spawning and egg incubation phases of the salmon's life history. Hatchery staff cannot simulate natural processes associated with mate selection. Eggs placed in incubators are not subject to the same selection pressures that affect those deposited in the streambed. These effects cannot be avoided; in fact, the primary purpose of hatcheries is to improve survival rates over those in the natural environment and this amounts to the removal of some of the selection pressures during these stages. Some genetically influenced traits, like body size, age at return, and time of return, are readily observable by hatchery managers. Hatchery managers can decide to interbreed adult fish based on these traits in order to achieve the desired management outcome relative to the establishment of integrated or segregated runs. Such decisions may produce results that are sometimes unintentional, such as advancing the run timing of a hatchery return by relying on fish from the early and middle portions of the run to ensure that broodstock goals are met. While no difference in run timing has been demonstrated during interim hatchery operations (Fresh et al. 2003), this remains a concern.

Artificial breeding also eliminates natural selection pressures related to males competing for females and the female choice in mate selection. There are many other traits that are not expressed physically and cannot be considered by hatchery managers when choosing broodstock.

Some phenotypic traits are known to affect fitness. For example, the ability of female sockeye to choose suitable nest sites is very important and is innate (not learned). In the river system, selection of a poor nest site can reduce the survival of embryos. Therefore, females that select poor nest sites are likely to produce fewer offspring than females that select good nest sites. The hypothesis is that, over time, this selection pressure would favor individuals that have the gene or genes that relate to good nest site selection, making these individuals more fit. It is not possible at the time of broodstock selection for hatchery managers to distinguish which females would be most adept at choosing the best nest sites. Therefore, hatchery management is likely to inadvertently allow females with poor nest selection traits to successfully produce offspring at the same level as females with good nest selection traits. For the fish that are spawned in the hatchery program, this removes the selection pressure relative to choosing nest sites, and these fish may subsequently contribute to an overall reduction in fitness of the sockeye population by choosing lower quality spawning sites.

Domestication impacts also result from management decisions that are not an intrinsic result of hatchery production. These decisions may be deliberate or unintentional. Selecting for specific traits has been a deliberate practice in some hatcheries in order to produce a segregated hatchery run to facilitate management of the hatchery stock. For example, hatchery managers might choose to deliberately select early arriving fish for breeding to advance run timing and allow higher harvest rates on hatchery returns compared to the natural run. Changes in run timing have also been the result of hatchery management decisions as explained above. Either way, management decisions can result in a fairly rapid change in the average date of return of the

hatchery population. Historically, segregated hatchery runs were thought to be beneficial from a resource management perspective because they allow a distinct temporal separation between hatchery-origin and naturally produced fish. This can allow fishing to be targeted primarily toward hatchery-origin fish since they might return to spawn much earlier than wild or naturally produced fish. While this practice may have benefits from a fisheries management standpoint, it can also significantly impact the population of naturally produced fish when hatchery fish interact with the natural population. High levels of natural spawning by hatchery-origin fish from a segregated hatchery management program can impose potentially unacceptable risks to natural populations (HSRG, 2004a). In most cases, it is difficult to maintain separation between hatchery and natural populations in a segregated hatchery management program because of unpredictable factors, from weather to harvest levels to natural variability of return timing in the naturally produced population. Such factors make it difficult to ensure that all hatchery-produced fish are either caught by fishermen or collected for broodstock. The proposed hatchery operating protocols have been specifically designed to ensure an integrated run and avoid, to the extent possible, domestication pressures that are solely related to management decisions.

In summary, domestication is a concern for this project because:

- Breeding sockeye in the hatchery could relax the selection pressure for certain traits that would be selected against in the wild. (For example, choosing poor nest sites as described above.) Because hatchery production does not select against these unfavorable traits, there is an equal likelihood of either negative or positive traits being passed on to the next generation. These hatchery-produced fish may return and spawn naturally and could have lower fitness as a result.
- Sockeye with hatchery-selected traits could interbreed with naturally produced sockeye, thereby passing genetically based hatchery-selected traits to their offspring.
- As with homogenization and straying, domestication could result in a reduction in fitness of subsequent generations of Cedar River sockeye.

3.2.4.2 What specific assumptions were used in the worst case analysis of domestication?

Additional assumptions used in the worst case analysis for domestication include:

- Domestication can occur as a result of selection pressures present during either the juvenile or adult phases of the sockeye life cycle.
- No more than 50%, calculated on a long-term average, of the adult sockeye returning to the Cedar River would be of hatchery origin.
- Rearing and feeding of fry at the hatchery would be limited, occurring for no longer than 2 weeks. (The longer fry are held at the hatchery, the more likely it is for artificial selection to occur.)

3.2.4.3 What is the likelihood that domestication will occur?

The proposed hatchery will be operated to reduce or eliminate domestication resulting from management decisions such as selecting only early returning fish for broodstock or simply breeding the largest fish with the largest fish. However, domestication is inevitable in any hatchery population because of the relaxation of some natural selection pressures. It is expected that the proposed Cedar River Sockeye Hatchery will result in domestication as a result of the inherent hatchery management effects discussed earlier. The risks and magnitude of hatchery effects are thought to be somewhat proportionate to the time spent in the artificial environment and the number of generations that a stock has been isolated in the hatchery. Assessments of hatchery impacts on fitness have not included programs like that being implemented for the Cedar River in terms of key factors thought to affect fitness: local stock, broodstock collection protocol, breeding protocol, release of fry soon after emergence, rate of naturalization and species. The existing literature focuses mostly on programs using hatchery stocks of steelhead, coho, and Chinook using extended freshwater rearing. With few exceptions, where fitness has been measured in these programs there has generally been a decline in fitness, with substantial variability among various assessments. Reisenbichler and Rubin (1999) reviewed several studies and concluded that substantial change in fitness results from traditional artificial propagation of anadromous salmonids held in captivity for one-quarter or more of their life. They noted that "to date almost no comparable data are available for species or populations that are held in captivity for shorter portions of their life: … [including] some sockeye populations." It is apparent from the literature that there is a need for further research into the effectiveness of various hatchery reform measures and to assess fitness in programs such as that being proposed for the Cedar River sockeye.

Even though the literature has not dealt directly with programs like the proposed replacement hatchery, the literature is helpful in identifying what monitoring is needed and in establishing factors that influence fitness. For example, there is evidence that the potential for genetic and phenotypic change is proportional to time spent in the hatchery. There is additional evidence that the use of local stock results in higher fitness in hatchery releases. Genetic principles suggest that random breeding and high male-to-female spawning ratios will help to avoid genetic change. The culture strategy for the proposed replacement hatchery has been developed with the benefit of this knowledge and has considered how to incorporate approaches that are thought to minimize the risk of genetic effects. Nevertheless, it is not possible to eliminate such risks. Thus, the question of how unavoidable domestication selection will affect fitness will need to be addressed through evaluation guided by the Adaptive Management Plan. The potential consequences, case-specific variability in hatchery practices, species and environmental factors and the limited understanding of the effects of naturalization underscore the importance of monitoring and being responsive to information as it becomes available. See Appendix C in this document for further review of information on this topic.

3.2.4.4 What is the magnitude of potential impact from domestication resulting from hatchery operations?

The workshop group concluded that the impacts to fitness of naturally spawning sockeye salmon over a 50-year period resulting from domestication closely parallel those for homogenization.

Under the worst case assumptions, the chance of less than a 10% reduction in fitness as a result of domestication was estimated to have a median value of 65% as a result of the worst case scenario. The chance of a 10% to 20% reduction in fitness was estimated at a median value of 29%, and the chance of a 20% to 30% reduction was estimated at 3%.

Some of the factors that affect domestication can be controlled through hatchery operations, and some cannot be controlled. The hatchery broodstock includes a high proportion of natural-origin fish that have been subject to natural selection pressures, as well as fish that are offspring of fish spawned in the hatchery. Fry will be released soon after emergence from the incubators, to minimize hatchery influences and approximate natural conditions as closely as possible.

~~Experience with the current sockeye salmon hatchery provides some insight into the short-term effects of domestication. In brood year 1995, nearly all natural eggs in the Cedar River were eliminated by scour caused by high flows, and this resulted in an unusually high proportion of hatchery fry leaving the Cedar River in 1996. Subsequent returns from this brood year and the subsequent brood year (1999) reproduced successfully in the river. While many factors influence survival, these progeny, from a group primarily composed of hatchery-origin fish, appear to have returned and spawned successfully and themselves produced progeny that were able to survive and reproduce (Seiler and Kishimoto, 1997; Seiler et al., 2002; S. Schroder, WDFW, personal communication).~~ Many factors affect sockeye fry production in the Cedar River: some are biological while others are physical or environmental (e.g. high flows, substrate). Nevertheless, comparing data on annual fry production from natural spawners from a baseline period prior to hatchery returns with that since the interim hatchery began contributing adult spawners can provide some indication of whether the interim hatchery is having a large adverse impact on population fitness. During the time that the hatchery has contributed to returns, the level of natural fry production has risen, both in absolute terms and in the rate of production (fry per spawner). Fry trapping and estimation began with the outmigration year of 1992, and the interim hatchery began to contribute to natural production in 1996. From 1992-1995, when all spawners were produced in the River (no hatchery influence), sockeye fry production from natural spawners averaged 15.9 million per year. From 1996 through 2005, sockeye fry production from natural spawners (comprised of natural and hatchery origin returns) averaged 24.4 million per year. Average productivity (fry per natural spawner) was 179 from 1992-1995 and was 233 for 1996-2004 (data source: annual WDFW reports by Seiler et al.). While favorable environmental factors could mask reduced fitness, the data available to date do not indicate that a downward trend in productivity is occurring during operation of the interim hatchery.

3.2.4.5 What can be concluded about impacts to the Cedar River sockeye population from domestication?

The scientists agreed that some level of domestication is likely, if not inevitable, especially regarding adult traits associated with reproduction. It is difficult to determine how much these changes would actually affect the fitness of the population. However, based upon the interpretation of models, general knowledge of salmonid biology and genetics, and the limited available studies on the subject, the workshop group concluded that the worst case reduction in fitness would most likely be low, at less than 20%. The environment for embryo development

and emergence will differ from a natural one, but protocols developed for this hatchery will likely reduce domestication compared to most hatcheries. Some differences include taking a high percentage of natural-origin returns as broodstock and releasing fry soon after emergence. Prolonged rearing in the hatchery would likely increase the likelihood that domestication would affect the fitness of the population, but prolonged rearing is not part of the proposed operating protocols.

Since the Worst Case Analysis Workshop was held, WDFW released the final report by Fresh et al. (2003) that included information comparing hatchery and natural origin Cedar River sockeye during the period 1995-2000. The authors found several differences between hatchery and natural origin sockeye, including differences in the size of females of the same age, spatial spawning distribution and the timing of broodstock collection relative to overall run timing. No differences were found between hatchery and natural origin returns in age at maturity or run timing. Most comparisons of females of the same age indicated that hatchery returns were significantly smaller than those of natural origin. The authors indicated that the cause of these differences was unknown and offered two hypotheses to explain the differences. Based on the following, the findings in the Fresh et al. (2003) report do not change the conclusion that domestication is likely, but that the impact on fitness would likely be low:

- The authors conclude that the cause of this reduction is not known (see discussion in Appendix C).
- Size reduction is not consistently observed as a hatchery effect (see Appendix C).
- It is not known whether changes in spatial distribution would affect fitness.
- Size differences were small enough to not cause changes in age at maturity.
- There were no detected changes in run timing.
- The number of fry produced per natural spawner from the study years was at or exceeded pre-hatchery return levels.

This issue will continue to be monitored through the Adaptive Management Plan.

In summary, while domestication is likely to occur, under worst case conditions the reduction in fitness is anticipated to be low.

3.2.5 Primary Areas of Uncertainty Related to this Assessment

There are several areas of uncertainty relating to potential genetic impacts that will require continued investigation. Sockeye salmon in the Lake Washington basin exist in a constantly changing, complex system. It is uncertain whether straying rates might be influenced by potential future modifications of hatchery management practices. There are also uncertainties relating to the ancestry of Lake Washington sockeye. The extent to which discrete subpopulations exist in either the Cedar River or larger Lake Washington basin is not completely

understood. In addition, how to measure the effects of homogenization and domestication relative to other factors in the environment is unclear. It is also unclear how long it takes for these genetic changes to affect fitness. There are so many sources of variation in survival in Lake Washington and the marine environments through which the sockeye salmon migrate that it would be exceedingly difficult to detect a decrease in production by, for example, 10%, at the adult stage.

In addition to uncertainty as a result of data gaps, there are also issues of uncertainty that arise from how genetic impacts would be measured. The primary challenge is that genetic changes may not rapidly result in distinct consequences. Factors like reductions in fitness and in genetic diversity may or may not result in reduced productivity that can be identified and measured before it becomes significant. A true effect could be undetected because of high variation, a small number of independent samples, a small intrinsic effect, or a combination of these factors. Also, factors unrelated to genetic effects (such as habitat degradation) could reduce the per capita production of fry, and this could then be mistakenly attributed to a genetically based reduction in fitness.

The workshop group concluded that a study to try to directly measure changes in fitness related to genetic impacts from the proposed hatchery would probably be inconclusive because of the number of environmental variables that would have to be considered and the types of errors that are known to occur during stock assessment studies. The difficult nature of quantifying adults and fry would be combined with high levels of natural variation, and current uncertainty regarding the true relationships between density, flow, and fry production. These factors would probably make it difficult to detect any but the most dramatic reductions in fitness. Although easier to study from a statistical standpoint, genetic diversity is also an imperfect measure of impacts because the number of different types of genes in a population at a given time does not by itself directly indicate a change that reduces the ability of the population to persist. It is likely that by the time such changes could be directly observed, significant alteration to Bear Creek sockeye (in relation to straying) or Cedar River sockeye subpopulations (in relation to homogenization) would have already occurred.

Because of these uncertainties, genetic effects is an area of focus in the Adaptive Management Plan (AMP) as discussed below.

3.2.6 Monitoring and Adaptive Management

3.2.6.1 Will genetic impacts be monitored?

Straying. All hatchery fish would be marked to facilitate monitoring for straying. For the Bear Creek sockeye subpopulation, straying studies would be conducted periodically to evaluate whether numbers of strays are changing with increased returns. The results of straying studies would be reported in annual summaries of research results. No monitoring is planned for straying to other sockeye subpopulations in the Lake Washington basin.

Homogenization/Domestication. It is difficult to monitor homogenization and domestication directly. However, the AMP establishes several monitoring programs to detect changes in the

size, growth, and migration timing of hatchery and naturally produced fry and to track trends over time. Productivity, as measured by the numbers of naturally produced fry per adult, will be monitored, as will peak flows that influence the extent of scour-induced mortality. Data on fecundity, egg size, and age at maturation for hatchery and natural-origin adults will be analyzed within each year and over time to detect trends. Significant trends that indicate divergence of these two groups or reductions in natural productivity will need to be examined and management adjustments may need to be made. Differences would be important if hatchery fry exhibited a handicap or an advantage compared with natural fry that could lead to shifts in the composite nature of the sockeye population and, ultimately, affect the fitness of fish that spawn in the river. This issue is further discussed in Section 2 of the AMP.

Initial monitoring proposed in the AMP includes:

- Migration timing will be monitored through fry trapping at the mouth of the river. This monitoring is initially proposed for up to 16 years during the life of the Cedar HCP.
- Population composition and abundance of outmigrant fry will be estimated.
- Pre-smolt surveys will allow comparisons of size and survival between hatchery and naturally produced fry, identified by otoliths or other markings. These surveys will also be used to determine pre-smolt population composition.
- Adult returns will be monitored for changes in size and age at maturity by recovering otoliths from returning adults. At the same time the spawning date and location of the returning adults will be monitored to expose any changes over time.
- Fecundity and egg size will be monitored as well as reproductive success.
- The AMP also recommends that genetic samples be analyzed at intervals to determine if changes are occurring in the genetic composition of the population.

The frequency of monitoring and the study plans will be reviewed to ensure that the resulting data will be useful to detect differences that may emerge. Study results will be reviewed carefully and adjustments to studies may be suggested or additional studies may be required.

3.2.6.2 How will the Adaptive Management Plan respond to monitoring results?

The results of monitoring and research will be summarized and analyzed in reports that will be publicly available. The data on which the reports are based will also be publicly available. The Technical Work Group (TWG) will review reports as they become available, and independent scientists will be asked to review reports that are of particular importance in the evaluation of the project. The implications of the results will be considered in the adaptive management framework by the TWG and the Adaptive Management Work Group (AMWG) and by independent scientists when appropriate. Recommendations from these groups will be provided to the Parties to the LMA for consideration. The AMWG will consider scientific recommendations and public input in forming their recommendations to the Parties as to whether hatchery operations or the monitoring program need to change. The public will have an

opportunity to see data, reports, and recommendations and to comment to the AMWG and Parties.

If monitoring results suggest that straying or a divergence between hatchery and naturally produced fry (as indicated by the parameters discussed above) exceeds the specified threshold, the Parties will have to address the issue, relying on the advisory committees, independent scientists, and the public for input. A significant step in the evaluation will be to determine to what extent hatchery practices or production are influencing the observed results. Where hatchery operations appear to be influencing observed results, the AMP suggests several possible corrective actions. Actual corrective actions taken will be determined with input from the scientific panel, taking into account a wide variety of factors that may be influencing the results.

Greater detail regarding initial thresholds, corrective actions, and measures of success or failure for each genetic concern is provided in Section 2 of the AMP. As an example, if migration timing of hatchery fry is diverging from that of naturally spawning Cedar River sockeye, one option is to adjust the temperature regime used in the hatchery, which will affect emergence timing. If straying to Bear Creek appears to be increasing, production levels at the hatchery could be reduced or stopped, or release practices could be modified.

3.2.6.3 What other research and monitoring efforts will support the evaluation of genetic impacts?

Information gathered by others will be used to evaluate sockeye productivity over time. WDFW and the Muckleshoot Indian Tribe estimate sockeye abundance in the Lake Washington basin as well as tributaries, including the Cedar River. The Tribe estimates sockeye numbers as the fish pass the Hiram Chittenden Locks. WDFW and Tribal staff, in collaboration with King County and City of Seattle staff, conduct stream surveys to estimate the numbers of spawners. In the Cedar River, these data are collected by reach. WDFW crews conduct Lake Washington beach surveys annually. WDFW staff analyze otolith samples and record the origin of sockeye, which allows comparisons between hatchery and natural-origin sockeye.

It is also important to document environmental influences that can significantly affect productivity. The U.S. Geological Survey (USGS) provides publicly accessible provisional and final streamflow data for several gauging stations in the Cedar River, and these data would be used in calculations of redd scour flows. The data will help to account for variability in river production.

3.3 Predation

3.3.1 Context/Background of Potential Impacts

3.3.1.1 What parameters were used to evaluate worst case impacts for predation?

The parameter considered by the workshop participants to be the most appropriate for evaluating predation impacts from the hatchery operations, based on biological relevance to the population, conceptual clarity, and measurability, was the percentage change in survival of juvenile sockeye or Chinook salmon under worst case conditions, compared to current baseline conditions.

3.3.1.2 What assumptions were used in the worst case analysis for predation?

The following assumptions were used in the worst case analysis for predation in addition to the general assumptions given in Section 1.6.2.

- For Chinook salmon juveniles and smolts, the predation impacts addressed in the worst case analysis included (1) predation in the Ship Canal during February through July, and (2) predation in the Cedar River.[3] For sockeye salmon, the analysis includes (1) predation in Lake Washington throughout the year, and (2) predation on naturally produced sockeye fry in the Cedar River.
- Key predators considered in the analysis include:
  - Lake Washington: cutthroat trout, northern pikeminnow, bass, and other piscivores (fish eaters) including sculpin.
  - Cedar River: rainbow trout, cutthroat trout, and sculpin.
- Under rare circumstances, natural fry production could be 25% greater than the highest production level to date, resulting in up to 85 million fry total (both hatchery and wild).
- The peak of hatchery releases would be later in the year than they currently occur, in order to more closely match the peak of naturally spawned fish.
- Low numbers of threespine sticklebacks and age-1 longfin smelt might occur in Lake Washington over the winter and over the subsequent year, providing fewer alternative prey.
- The timing and abundance of Chinook and coho salmon released from the Issaquah Hatchery would not differ from current patterns and levels.

[3] Predation in Lake Washington was considered but the panel found that the influence of additional sockeye fry would have an insignificant effect.

3.3.2 Worst Case Analysis for Predation

3.3.2.1 Why is predation a concern for this project?

Predation refers to the consumption of juvenile sockeye or Chinook salmon by other fish species in Lake Washington or the Cedar River. Predation is a concern for this project because it could reduce the survival rate of juvenile salmon. If more juvenile salmon are available, the population of predators may increase opportunistically.

On the other hand, increased production of hatchery fish could have a beneficial effect by "buffering" juvenile salmon from predation (i.e., having more juvenile fish present because of the hatchery would allow more juveniles to survive predation).

3.3.2.2 What did the workshop participants conclude related to predation?

The workshop participants reached several key conclusions related to the worst case analysis for predation (below). See the workshop summaries in Appendix B for additional details.

The change in survival of juvenile salmon cannot be measured directly but can be measured indirectly using several indicators. First, survival for both Chinook and sockeye in the Cedar River can be estimated by dividing the abundance of juvenile salmon at the outmigrant trap by either the estimated egg deposition (the fry/egg ratio) or the number of spawners (the fry/spawner ratio). Second, the survival of sockeye in Lake Washington can be estimated by dividing the number of fry entering the lake (known from outmigrant trapping) by the abundance of pre-smolts (estimated from annual hydroacoustic-midwater trawl surveys). No method currently exists for estimating the survival of Cedar River Chinook salmon in Lake Washington.

The presence of hatchery-produced sockeye salmon is not anticipated to result in a significant change in the number or size of predators in Lake Washington. The workshop group concluded that the additional sockeye salmon juveniles would not increase the forage base for predators enough to increase predator populations in Lake Washington. Sockeye salmon currently contribute 10% to 20% of the annual prey biomass to predatory fishes in the lake and the Cedar River (Mazur, 2004). The panel concluded that even the anticipated doubling of sockeye salmon fry under assumed worst case conditions would not likely result in an increase in predator abundance or biomass.

The presence of hatchery-produced fry could increase predation through three main pathways. These include: (1) by attracting more predators, (2) by increasing the focus of predators on juvenile salmon as a food source, or (3) by concentrating the current population of predators at key interception points. The locations where this is most likely to occur include the mouth of the Cedar River, in the immediate nearshore areas of Lake Washington, and within the Ship Canal. The workshop group believed that the concentration of predators in these areas was the most plausible response to increased hatchery production of sockeye fry. However, the group identified that these three pathways are interdependent and cannot be considered independently in assessing impacts.

The new hatchery would increase buffering for sockeye fry in the river. The releases of sockeye fry from the new hatchery would be timed to more closely match the natural outmigration of sockeye fry from the Cedar River. This would result in higher numbers of sockeye in the river and would focus the peak of total sockeye outmigration closer to the peak of natural sockeye outmigration (currently the downstream migration of sockeye produced in the interim hatchery peaks earlier than the peak of naturally produced sockeye). Greater numbers of hatchery salmon released to coincide with the peak outmigration of naturally produced sockeye could "buffer" or absorb some of the predation pressure (Peterman and Gatto, 1978). Higher predation on naturally produced fry would be anticipated if no hatchery was operating, compared to either the current interim hatchery or the new hatchery.

The current timing in the release of sockeye from the interim hatchery is assumed to have a buffering effect on predation of Chinook fry[4] in the Cedar River. The buffering effect on Chinook predation would be reduced if hatchery releases occur later in the year. Under current conditions, sockeye juveniles are released from the interim hatchery earlier in the season, before the peak of naturally produced sockeye. This release timing coincides more closely with the peak for natural Chinook fry outmigration in the Cedar River (Seiler et al., 2001; Seiler et al., 2003). Therefore, the release of hatchery sockeye is believed to have a buffering effect on predation of Chinook fry because of the larger total number of salmon in the river at the same time. Most Chinook smolts[5] leave the Cedar River in May and June, and predation losses of smolts are not expected to be influenced by adjustments in the release timing of hatchery-origin fry. With the new hatchery, sockeye would be released later in order to mimic the peak of naturally spawned sockeye. This could result in increased predation on the early peak of migrating Chinook juveniles in the river. However, lower numbers of sockeye salmon early in the year compared to current baseline conditions with the interim hatchery may reduce the number of predators gathering within the lower river.

A potential decline in survival of Chinook salmon fry due to a reduction in predation buffering might be moderated by both biological and environmental factors. Despite the shift to later peak migration in the Cedar River by hatchery sockeye, increased hatchery production would still increase the abundance of the earliest portion of the hatchery run, coinciding with the early emerging naturally produced sockeye fry. The impact of less predation buffering would also be dampened by the higher stream flows and low temperatures during February. Lower temperatures reduce predation by reducing the activity and metabolic demands of predators, while higher flows reduce the efficiency of predators in feeding on fry in the Cedar River (Tabor et al., 1998, 2004; Seiler et al., 2001).

[4] Most Chinook leave the river as fry in late February to early March, soon after they swim up from the gravel. These fish generally grow for several months in Lake Washington until they are ready to enter salt water.

[5] Sockeye fry leave the Cedar River before Chinook smolts begin their outmigration; therefore, the predation buffering expected for Chinook fry would not be expected for Chinook smolts.

3.3.2.3 What is the likelihood that increased predation will occur?

The workshop group concluded that increased predation has a very low likelihood of occurring because of hatchery operations, using worst case assumptions.

3.3.2.4 What is the potential magnitude of the worst case impact of increased predation?

The workshop participants agreed that the project is highly likely to have neutral or minor effects on the survival of Chinook and sockeye, with a negligible chance (less than 5%) of an adverse impact on survival.

The consensus of the workshop group was that impacts to Chinook in the Cedar River would consist of a less than 10% shift (either positive or negative) from current fry survival rates, resulting from the interplay between reduced buffering by sockeye and other factors that would inhibit predation. Sockeye survival in the river is anticipated to increase slightly as a result of increased buffering by hatchery fish. The panel predicted a neutral or minor reduction (less than 5%) in survival of both Chinook and sockeye salmon during lake rearing and migration. This level of change likely falls within the natural level of variation, and would not likely be detected in the population.

3.3.2.5 What can be concluded about the impact to salmon from increased predation?

Although the shift in releases of hatchery fish would reduce the buffering effect of predation on juvenile Chinook in the river, the magnitude of this impact could be moderated by both biological and environmental factors. The primary potential for increased predation on Chinook is a result of the change in operation of the hatchery. These changes are intended to make the hatchery-origin fry as similar as possible to natural-origin fry. Impacts of predation as a result of the shift in timing of releases are anticipated to be no worse than if no hatchery is present (i.e., with only natural production of sockeye in the Cedar River) because there would be more fry in the river.

The increase in hatchery sockeye in the river would provide greater buffering for sockeye against predation throughout the outmigration period, leading to a minor improvement in survival of sockeye fry.

The workshop panelists felt that the neutral or minor reduction in survival of both Chinook and sockeye salmon during lake rearing and migration may not even be measurable given other factors. For example, fluctuations in the abundance of longfin smelt are anticipated to have a much higher impact on predation than increased numbers of sockeye. Longfin smelt are a primary prey item in the lake (Beauchamp et al., 1994; Nowak et al., 2004), with significantly more biomass than sockeye, even considering a 25% to 100% increase in fry. Also, during the period when greater numbers of outmigrant sockeye smolts could attract predators in the Ship Canal, millions of coho and Chinook smolts released from the Issaquah Hatchery would also be

present in the Ship Canal, resulting in increased predator attraction potential but also increased buffering.

3.3.3 Primary Areas of Uncertainty Related to this Assessment

How predators respond to changes in the abundance of the food supply is not fully understood. While there have been no direct studies, theoretical knowledge and indirect measures have been used to assess the potential responses of predators to changes in food abundance. This is an area that will continue to be evaluated as new information becomes available.

3.3.4 Monitoring and Adaptive Management

3.3.4.1 Will predation be monitored?

Ongoing assessments of the numbers of sockeye and Chinook fry entering Lake Washington and the numbers of pre-smolt sockeye remaining after one year in the lake will provide some information on mortality rates. Most of this mortality is assumed to be from predation. These results are expected to be published annually. Whether predation will be studied in greater depth depends on the level of uncertainty associated with this effect, and that will be determined through the adaptive management process of setting priorities for monitoring. There currently is a placeholder in the AMP for studies of predator abundance; however, these studies will be carried out only if studies of survival indicate a need for increased investigation or if additional resources can be found.

3.3.4.2 How will the Adaptive Management Plan respond to monitoring results?

The AMP recognizes the possibility that predation may become an issue and includes discussion of this factor. However because the risk, even in a worst case analysis, is considered to be quite low, no specific studies are planned. If other studies indicate that there are issues related to fry survival that need to be addressed, discussions would occur through the normal AMP decision-making process and resources could be directed at studies of predator abundance. The results of these studies could suggest changes in production levels or release strategies at the hatchery.

3.3.4.3 What other research and monitoring efforts will support the evaluation of predation?

Funding has been available in recent years to support the insertion and detection of passive integrated transponder (PIT) tags in sockeye, Chinook, and coho. Tagged fish have been released from the Cedar River, Bear Creek Issaquah Hatchery, and within Lake Washington. This research has provided some indication of the losses of larger juvenile salmon that occur in Lake Washington. Most of these losses are presumed to be due to predation.

3.4 Food Supply and Competition Impacts

3.4.1 Context/Background of Potential Impacts

3.4.1.1 What parameters were used to evaluate worst case impacts for food supply and competition?

The impacts of competition for food supply can be measured directly as a reduction in the growth of juvenile Chinook or sockeye salmon in Lake Washington. If there were insufficient food to sustain Chinook and/or sockeye as they rear in Lake Washington, then their growth rates would reflect that deficit.

For Chinook salmon, the impact of competition was assessed for rearing juveniles and smolts in Lake Washington. For sockeye salmon, competition impacts were also assessed for juveniles and smolts in Lake Washington.

3.4.1.2 What worst case assumptions were used in the analysis of food supply and competition?

The following assumptions were used in the worst case analysis for food supply and competition in addition to the general assumptions discussed in Section 1.6.2:

- The current prey base for Chinook and sockeye during the time that these species overlap in Lake Washington will remain the same as presently occurs. Chinook feed primarily on chironomid (midge) pupae. Sockeye feed primarily on cyclopoid copepods (a type of small crustacean) offshore but also feed on chironomid pupae in nearshore areas (Beauchamp et al., 2004) during winter through spring, then feed predominantly on *Daphnia* from mid-May through December.
- Variations in zooplankton densities will be unchanged from current conditions.
- Food is not presently a limiting condition for sockeye. This is based on the fact that (1) sockeye are currently thought to consume less than 20% of the available and exploitable biomass of prey in the lake; and (2) there has been no evidence of a reduction in growth of sockeye fry or smolts despite a five-fold increase in fry abundance in the lake over the past decade (10 million to 52 million fry) during operation of the interim hatchery (Beauchamp et al., 2004).

3.4.2 Worst Case Analysis for Food Supply and Competition

3.4.2.1 Why are food supply and competition a concern for this project?

Increased hatchery production of sockeye salmon fry would increase the consumption of zooplankton or other shared food resources in Lake Washington. If food supply became limiting as a result, then the new hatchery could create negative impacts on growth and hence the survival of fry in the lake through competition.

3.4.2.2 What did the workshop participants conclude related to food supply and competition?

The workshop participants reached several key conclusions related to the worst case analysis for food supply and competition (below). See the workshop summaries in Appendix B for additional details.

Competition for food could have direct or indirect effects. Competition could potentially increase the mortality of salmon directly (through starvation) or indirectly (by increasing vulnerability to predation because of reduced growth/smaller body size or debilitated condition).

Chinook and sockeye salmon have different but overlapping feeding habits in the lake. In Lake Washington, juvenile Chinook salmon feed almost exclusively on chironomid pupae from February until mid-May (Koehler, 2002), and grow more rapidly than either Chinook in stream habitats or sockeye in the lake during this period. Juvenile sockeye salmon feed primarily on cyclopoid copepods during winter and early spring, but a relatively small segment of the juvenile sockeye population also eats chironomid pupae when captured in nearshore habitats (Beauchamp et al., 2004). Therefore, an increased number of sockeye salmon in the lake could increase the demand on chironomid pupae in nearshore habitats where Chinook occur from February through mid-May.

The supply of zooplankton in Lake Washington exceeds the demand by species that feed on zooplankton. Zooplankton densities in the southern half of the lake decline dramatically in mid-March through early April. Despite this seasonal decline in food, the largest recorded population of sockeye fry consumed less than 20% of the biomass of exploitable zooplankton available in the southern regions of the lake, where most planktivorous species were distributed during winter and early spring. When the population of *Daphnia* (a type of small crustacean) increases in mid-May or early June, most planktivorous species switch to this abundant food source, and both sockeye and Chinook salmon feed heavily on *Daphnia* in offshore waters. As the seasons progress, other species consume as much or more zooplankton than juvenile sockeye. Yet despite the increased demand, the combined planktivore community consumes less than 5% of the average monthly biomass of *Daphnia* during the May-November growing season (Beauchamp, 1996, and unpublished data).

3.4.2.3 What is the likelihood of increased food competition affecting salmon in Lake Washington?

The workshop panelists felt that the likelihood of increased competition affecting salmon in Lake Washington is low. Juvenile Chinook salmon in the lake are unlikely to be affected by competition from the higher density of juvenile sockeye assumed under the worst case scenario. This is because of (1) the difference in habitat use and diet between juvenile Chinook and sockeye and thus the limited opportunities for competition, (2) the rapid growth rate of Chinook salmon in the lake during winter and spring, (3) the abundance of prey in the lake, and (4) the lack of evidence of reduced sockeye salmon growth in the lake with operation of the interim hatchery. In addition, other factors such as releases of Chinook from the Issaquah Hatchery are more likely to result in direct competition for food with naturally spawned Chinook fry.

3.4.2.4 What is the potential magnitude of the impact of increased food supply and competition on salmon in Lake Washington?

The project is expected to have a neutral effect on Chinook and sockeye salmon through increased competition in Lake Washington, resulting in a less than a 5% reduction in survival.

Similar to Chinook salmon, sockeye are unlikely to be significantly affected by competition due to the abundance and composition of prey in the lake. Because sockeye salmon consume a relatively small fraction of the zooplankton forage base throughout the year, even a doubling of the number of sockeye salmon from current hatchery levels is not anticipated to significantly reduce the overall availability of food in the lake. There is no evidence of reduced sockeye salmon growth in the lake during the operation of the interim hatchery despite substantial variability in the numbers of sockeye fry that enter the lake (Beauchamp et al., 2004). Other factors such as the abundance of longfin smelt are more likely to influence competition for food in the lake (Beauchamp et al., 2004).

3.4.2.5 What can be concluded about the impact to salmon in Lake Washington from food supply and competition?

Due to the difference in habitat use and diet between juvenile Chinook and sockeye, and the rapid growth rate of Chinook salmon in the lake during winter and spring, juvenile Chinook salmon in the lake are unlikely to be affected by competition from the higher density of juvenile sockeye assumed under the worst case scenario. Because the forage base for sockeye does not appear to presently limit growth, and because the proposed hatchery is not anticipated to create a condition whereby food would become limiting to sockeye, sockeye salmon are also not likely to be affected by increased competition as a result of the hatchery. Some workshop participants noted that these assumptions are based on current levels of abundance and current species composition of prey in the lake, and that factors unrelated to the proposed hatchery, such as global warming or the introduction of new exotic species, could change these parameters and the resulting conclusions.

3.4.3 Primary Areas of Uncertainty Related to this Assessment

The long-term trends of zooplankton dynamics are not entirely understood. A warming trend has been recorded in Lake Washington that could influence zooplankton species composition and abundance. Changes in nutrients could result from increased development around the lake and could continue to influence zooplankton populations.

3.4.4 Monitoring and Adaptive Management

3.4.4.1 Will food supply and competition be monitored?

The growth of sockeye juveniles and other species will be monitored through March sampling each year. Additional data will be collected in October in some years. These data will be examined for trends as a function of planktivore abundance or biomass. Zooplankton levels will be monitored in the spring to evaluate early feeding conditions for sockeye fry. Reductions in growth could indicate that there is a problem with sufficient food resources in Lake Washington. Results will be reported annually.

3.4.4.2 How will the Adaptive Management Plan respond to monitoring results?

If monitoring suggests that salmonid growth rates are declining with increased abundance of sockeye, the AMP calls for an evaluation of the effects on adult returns and, if warranted, evaluating the cause of the decline. The committees and Parties of the adaptive management process would assess zooplankton abundance over time and other available information on biological and physical parameters to determine the appropriate response. The AMWG could recommend reducing or halting hatchery production, implementing additional studies to better understand the role of food resources in the detected reduction in growth rates, or other appropriate response strategies. If it is apparent that growth rates are influenced by sockeye abundance, then hatchery production levels would likely be capped or reduced, depending on the committee recommendations and decision by the Parties to the LMA.

3.4.4.3 What other research and monitoring efforts will support the evaluation of food supply and competition?

The University of Washington had funding to collect zooplankton data in Lake Washington through 2004. A long-term database exists for Lake Washington, allowing comparisons between years and detection of trends over decades. These baseline data could be used to better understand if changes in sockeye production affect sockeye prey abundance and species composition.

3.5 Spawning Ground Competition Impacts

3.5.1 Context/Background of Potential Impacts

3.5.1.1 What parameters were used to evaluate worst case impacts related to spawning ground competition?

The overall parameter considered for spawning ground competition between Chinook and sockeye salmon was reduced Chinook egg-to-fry survival. Survival could be affected by:

- The amount of energy expended by Chinook in defending their redds against sockeye;
- Selection of spawning sites by Chinook in the presence of sockeye; and
- Distribution of Chinook along the river as a function of the density of sockeye.

3.5.1.2 What assumptions were used in the worst case analysis of spawning ground competition?

Some of the general assumptions discussed in Section 1.6.2 were not applicable to this particular analysis. Spawning ground competition is a result of increases in adult returns to the Cedar River, not increased production at the hatchery. This analysis assumed that the adult returns to the river would increase by 50%, from approximately 200,000 adults to 300,000 sockeye (including hatchery fish) that might return with the proposed hatchery in operation. The hatchery co-managers have established a target goal of 300,000 sockeye spawning in the Cedar River.

3.5.2 Worst Case Analysis for Spawning Ground Competition

3.5.2.1 Why is spawning ground competition a concern for this project?

Spawning ground competition refers to competition between fish for spawning areas. Spawning ground competition is a concern for this project because Cedar River Chinook salmon, which are listed as threatened under the Endangered Species Act, spawn in the Cedar River at about the same time as Cedar River sockeye. Hypothetically:

- An abundance of sockeye could displace Chinook to spawning sites of lesser quality or force Chinook to move farther upstream to spawn.
- Chinook might need to expend more energy to guard their redds against sockeye, thus leading to earlier death of spawning Chinook and less time spent guarding their redds.

3.5.2.2 What did the workshop participants conclude related to spawning ground competition?

The workshop participants reached several key conclusions related to the worst case analysis for spawning ground competition (below). See the workshop summaries in Appendix B for additional details.

Workshop participants agreed that Chinook salmon dominate on the spawning grounds and are not displaced by aggressive sockeye. General observations confirm that sockeye tend to avoid Chinook. Chinook do not appear to expend large amounts of energy in aggressive behavior toward sockeye. Female Chinook are more assertive than males in defending spawning sites. However, competition is primarily between salmon of the same species, except perhaps if disturbance is caused by sheer numbers of fish around the redd site of the Chinook. The energy expended by Chinook in defending a female or a redd site from sockeye was considered minor compared with the interaction between Chinook. Some scientists have observed that pink, chum and sockeye females do attack those of other species. However, this was in a spawning channel where strong spatial segregation could not occur (T. Quinn, personal communication, 2005).

Observations in the Cedar River also indicate that Chinook may move to secondary areas where sockeye are not present, but these secondary sites are no less effective for spawning. Chinook appear to select different sites when sockeye are numerous than in years when sockeye are less abundant. As stated above, this is not the result of aggressive behavior by sockeye, but rather it may indicate that Chinook are simply avoiding the annoyance of a large number of sockeye by moving to sites sockeye are not able to occupy. Chinook generally spawn in areas that have greater depth and velocity than the areas where sockeye spawn. Chinook can avoid sockeye by moving to such locations without difficulty, and without greater risk to the survival of Chinook eggs because of the size of gravel and depth of their redds in the favorable intergravel flows associated with deeper water.

An abundance of sockeye is unlikely to cause Chinook to move substantial distances upstream or downstream. Deeper or faster water is more likely to be the alternative selected by Chinook for spawning than areas farther upstream. The timing and location of spawning are related to water temperature; for example, fish spawn at different locations early in the season than later spawning fish. This suggests that Chinook may~~would~~ move to deeper or faster water in the same general area to avoid an abundance of sockeye, rather than moving upstream or downstream for any substantial distance (Brannon ~~and Powell~~ et al., 2004b).

3.5.2.3 What is the likelihood that spawning ground competition will occur?

While Chinook may spawn in different areas due to the presence of sockeye, this represents avoidance behavior as opposed to competition. When there is avoidance behavior, Chinook may alter their spawning locations in response to the presence of sockeye, but their new choice would be equally as suitable as that now occupied by sockeye. In contrast, competition presumes that the alternative spawning location chosen by Chinook would be less suitable than the location now occupied by sockeye. The workshop panelists agreed that the likelihood that spawning ground competition will occur is low.

3.5.2.4 What is the magnitude of the potential impact from spawning ground competition on Chinook salmon?

Under the worst case scenario, increased adult returns of sockeye would result in an insignificant reduction in the energy available for spawning by Chinook. This would translate into a low probability of a minor reduction in survival of Chinook (estimated at a 100% chance of reducing Chinook egg-to-fry survival by less than 10%).

The workshop panelists also agreed that displacement of Chinook from preferred spawning sites as a result of high densities of sockeye would also have a low impact, although there was slightly more variation in their conclusions than in the previous discussion. The possibility that Chinook would experience higher egg mortality if they were displaced is estimated at a 50% to 100% probability of a less than 10% impact on Chinook survival, and a 25% to 50% probability of a 10% to 20% impact on Chinook survival. This implies that under what would be considered typical conditions (with little interactive behavior), Chinook salmon egg-to-fry survival would not be influenced.

3.5.2.5 What can be concluded about the impacts to Chinook survival from spawning ground competition?

The potential effect of increased sockeye density on Chinook salmon selection of spawning sites appears to be primarily a nuisance factor. Chinook are not displaced to poor-quality sites because of aggressive interference from sockeye. Chinook may move to secondary areas to avoid large numbers of sockeye, but these secondary areas are probably as effective for spawning. An abundance of sockeye is unlikely to cause Chinook to move substantial distances upstream or downstream. The workshop group generally agreed that the potential risk to Chinook survival from spawning ground competition by sockeye salmon is low.

3.5.3 Primary Areas of Uncertainty Related to this Assessment

There is limited information regarding the frequency of occurrence or the magnitude of impact as a result of spawning ground competition in the Cedar River. Most of the conclusions reached were extrapolated from data or observations in other basins and/or relative to other species. Information on Chinook and sockeye interactions in the Cedar River is largely anecdotal.

3.5.4 Monitoring and Adaptive Management

3.5.4.1 Will spawning ground competition be monitored?

The data needed to calculate fry production per spawner are currently collected and will continue. This overall assessment is affected by many factors, but is intended to detect trends over time. Spawning ground competition could be one of many factors that could affect the survival rate. Annual redd surveys will continue to note Chinook/sockeye interactions on the spawning grounds.

3.5.4.2 How will the Adaptive Management Plan respond to monitoring results?

Data on survival rates of Chinook will be evaluated in the adaptive management process. If an unusual decline in Chinook incubation survival rate occurs, an evaluation will be made of whether additional research into the underlying causes or some other change is warranted. Among the actions which could be recommended by the AMWG would be altering release locations, reducing or stopping hatchery production, or modifying harvest to reduce the escapement goal.

3.5.4.3 What other research and monitoring efforts will support the evaluation of spawning ground competition?

The Chinook redd surveys are currently funded by the King Conservation District. The occurrence of redds is used to establish an alternative estimate of Chinook spawning in the Cedar River.

3.6 Superimposition Impacts

3.6.1 Context/Background of Potential Impacts

3.6.1.1 What parameters were used to evaluate worst case impacts from superimposition?

The overall parameter considered for superimposition impacts between Chinook and sockeye salmon was reduced Chinook salmon survival. For superimposition, survival could be affected by:

- The percent of surface overlap between sockeye redds and Chinook redds;
- The percent of sockeye females large enough to penetrate Chinook egg pockets; and
- Increased siltation associated with redd formation and spawning activity.

After further discussion, workshop participants dismissed siltation from the analysis because they felt that it was a minor influence on the incubation process. Siltation in Chinook redds could result from the combination of silt effects from the bedload as well as disturbance of the substrate by spawning sockeye. The Cedar River was thought to carry a relatively low level of silt in its bedload. The participants referred to research on the effect of siltation in other river systems (Bjornn and Reiser, 1991). That work suggests that the projected increase in adult sockeye mobilizing silt in the Cedar River environment would not have a significant effect on the survival of eggs in Chinook redds in the Cedar River.

3.6.1.2 What assumptions were used in the worst case analysis for superimposition?

The following assumptions were used for the worst case analysis for superimposition of redds:

- The workshop group assumed that only 5% of the sockeye females would be large enough to be able to modify the large substrates in the egg pocket of a Chinook redd.
- A sockeye redd in the Cedar River will overlap about 10% to 15% of the area occupied by a Chinook redd (K. Burton, personal communication, 2004).
- The worst case would be two to three sockeye redds superimposed on all Chinook redds. This would result in an estimated 20% to 45% of the Chinook redd surface area being impacted by spawning sockeye.

3.6.2 Worst Case Analysis for Superimposition

3.6.2.1 Why is superimposition a concern for this project?

Superimposition occurs when a salmon digs a redd that overlaps into the existing redd of another salmon. For this project, the issue is the superimposition of sockeye redds on top of existing Chinook redds. As mentioned previously, Cedar River Chinook salmon are listed as threatened under the Endangered Species Act. Superimposition is a concern because:

- Digging by sockeye into a Chinook redd could damage or dislodge Chinook eggs or alevins.
- Digging by sockeye could cause silt to settle around and smother Chinook eggs if the alevin stage is not reached or the alevin is not mobile enough to escape.

3.6.2.2 What did the workshop participants conclude related to superimposition?

The workshop participants reached several key conclusions related to the worst case analysis for redd superimposition (below). See the workshop summaries in Appendix B for additional details.

Chinook redds are deeper than sockeye redds and contain larger substrate (Crisp and Carling, 1989; Devries, 1997; Steen and Quinn, 1999). While species differences exist in average redd depth, the primary factor responsible for spawning depth is fish size. Chinook redds are deeper than sockeye redds because Chinook are larger. The cobble that defines the nest pocket of a Chinook redd is too large for most sockeye to move easily and thus provides a protective barrier against sockeye digging activity.

The potential risk for disturbing Chinook eggs is limited to the largest sockeye (assumed to represent only 5% of the sockeye females). Based on size data for Chinook and sockeye salmon provided by workshop participants (WDFW unpublished data), there is very little overlap

in size between the smallest Chinook females and the largest sockeye females. For purposes of this discussion an overlap of 5% was assumed. Size was considered important because the depth of redd digging by female salmon is affected by the salmon's size. Therefore, the potential impact of superimposition is mainly limited to only the largest sockeye.

The timing of female Chinook guarding behavior would limit impacts to Chinook eggs. Sockeye have been observed to move onto Chinook redds as soon as the redds are vacated, but Chinook eggs are not as susceptible to mechanical disturbance after 10 days of development as they are earlier in their development. Chinook females live in the stream for most or all of that period, which means that during most of the sensitive embryo development stage, the eggs are protected by the female guarding the redd. Once the female vacates the redd, mortality of eggs after that 10-day period would have to be from excavation rather than shock abuse. Eyed eggs are susceptible to predation once they are excavated from the nest pocket, but alevins tend to burrow in the gravel and remain hidden when disturbed by excavation.

3.6.2.3 What is the likelihood that superimposition will occur?

Existing data demonstrate that high rates of superimposition do occur in some years. However, even if all Chinook redds are superimposed with spawning activity from sockeye, the likelihood of significant mortality is low. As stated above, the area of a Chinook redd that could be superimposed by a single sockeye redd is 10% to 15%. More importantly, the sockeye would have to remove the larger substrate in which the Chinook eggs are nested. As Chinook dig their nests, the large cobble sinks to the bottom of the excavation because the Chinook cannot remove it out of the nest pocket. Even if sockeye females could dig deep enough to reach the Chinook eggs, they would be expected to have difficulty moving the cobble that defines the nest pocket that protects the Chinook eggs.

3.6.2.4 What is the magnitude of potential impacts to Chinook survival from superimposition?

Under the worst case assumptions identified above, including an abnormally large proportion of sockeye females capable of digging as deep as Chinook salmon, 1.5% of all Chinook eggs could die prior to hatching.

This calculation was based on the following assumptions: (1) Every Chinook redd has, on average, three sockeye redds superimposed on it (100% superimposition); (2) each sockeye redd is independent of the other and each covers 10% of the Chinook redd (30% of the area of all Chinook redds are therefore subject to superimposition); and (3) 5% of the sockeye are large enough to dig deeply enough to affect Chinook eggs in the redd (all Chinook eggs affected by these large sockeye are assumed to die). The result of making these worst case assumptions is the loss of 1.5% of the Chinook eggs that are deposited in the river.

If one used the higher figure of 15% for the area of superimposition by individual sockeye females, the final calculation would be a 2.25% loss of Chinook eggs in the river. Thus, even assuming 100% superimposition, a large surface disturbance, and mortality of all of the eggs in

each area of superimposition, only a small proportion of the egg population would be affected under worst case assumptions. Therefore, the workshop panelists felt the potential magnitude of impact is low to non-existent.

This conclusion of impact is supported by the information collected by WDFW on Chinook fry production in the Cedar River. Dave Seiler of WDFW referred to data at the workshop that showed estimates of survival for Chinook from the egg to fry stages for 5 years. In brood year 2002, the highest documented superimposition rate (88%) (Burton et al., 2003) corresponded to the highest Chinook survival rate since brood year 1998, when Chinook estimates were first made. If superimposition were having a substantial impact, the results from brood year 2002 would be very unlikely.

3.6.2.5 What can be concluded about the potential impacts to Chinook survival from superimposition?

The workshop group concluded that the impact from redd superimposition would be minor, with the probability for a reduction in survival of less than 10%. This was the lowest range of impact that the group could have chosen in its analysis.

3.6.2.6 Primary Areas of Uncertainty Related to this Assessment

There is limited information regarding the frequency of occurrence or the magnitude of impact as a result of redd superimposition in the Cedar River. Most of the conclusions reached were extrapolated from data or observations in other basins and/or relative to other species. Information on Chinook and sockeye interactions in the Cedar River is largely anecdotal.

In addition, the exact length of time that female Chinook salmon guard their redds is uncertain, as is the precise burial depth of eggs. It is unknown if sockeye activity on or near Chinook redds early during incubation would create additional mortality directly, through movement of the eggs, or indirectly, by creating additional water turbulence. It is also unknown how redd depth might change if two or more sockeye redds overlap and what the corresponding effect would be if this occurred within a Chinook redd.

3.6.3 Monitoring and Adaptive Management

3.6.3.1 Will superimposition be monitored?

The fry trapping operation near the mouth of the Cedar River will continue to assess annual Chinook production from the river. Adult surveys funded by non-project sources are collecting data on Chinook abundance and redd superimposition. The average number of Chinook produced per spawner (adjusted for flow) will be compared with the superimposition rate to see if a significant relationship is detected over time.

3.6.3.2 How will the Adaptive Management Plan respond to monitoring results?

Data from surveys and fry trapping will be evaluated in the adaptive management process. Data from all years will be evaluated to see if there is evidence for a relationship between the superimposition rate and Chinook egg-to-fry survival rates after accounting for environmental variables. If there is evidence for a relationship, the TWG will assess the potential causes and make recommendations for an appropriate response. This information will be forwarded to the Parties to the LMA and/or the hatchery co-managers. Possible responses would include reduction or cessation of hatchery production or increases in harvest to lower the number of sockeye spawning in the river.

3.6.3.3 What other research and monitoring efforts will support the evaluation of superimposition?

Cedar River adult Chinook surveys are supported by King Conservation District, WDFW, King County, and the City of Seattle. While continued funding of these surveys is not guaranteed, these surveys are expected to continue for some time due to the importance of the data to monitoring and managing a population listed under the Endangered Species Act.

The USGS records river flow data that is needed to account for the effects of scour on survival during incubation.

3.7 Cumulative Impacts

Numerous factors may affect the long-term potential for a self-sustaining sockeye population in the Lake Washington basin. These include the gradual warming of Lake Washington, effects of urbanization including altered flow regimes, increased nutrient and pollutant loads, increased levels of sedimentation, loss of riparian habitat, and increased fishing pressure. These factors may ultimately play a more significant role in determining the long-term viability of sockeye in the Lake Washington basin than potential impacts to genetics from hatchery operations. It will be important to consider all of these factors as the Lake Washington system evolves, acknowledging that genetic impacts are only a part of the entire system. Genetic diversity will be one of several factors affecting the ability of salmon to adapt to environmental changes.

Changes in predation rates caused by increased hatchery production may be a small component relative to the factors affecting the long-term population dynamics of sockeye or other salmonid populations. Basin-wide changes in nutrient additions associated with increased urbanization have had far-reaching impacts on the productivity of Lake Washington. Introductions of fish have affected both predator and prey abundance. In addition, continued changes in the temperature regime of the lake could change the interactions between predation and growth in ways that could be significant. The predator population has been supplemented through the introduction of non-native species. The abundance of various predatory species may change over time as they become established or as they respond to changes in their environment. Because of the complex array of factors that influence predation dynamics, there is less than a

5% chance that the impacts from hatchery operations would result in a significant change in predation in any one year. Predation effects would be variable and isolated among years, rather than being cumulative over the 50-year life of the project.

Environmental changes beyond the control of hatchery managers have a potential to affect food supply and competition in the Lake Washington system more significantly than increased competition from the additional hatchery releases. These include changes in the thermal regime within the lake and the nutrient balance, which could affect zooplankton distribution, density, and composition. The potential for competition from the 17 million additional hatchery fry to result in biologically significant impacts is seen as very low, but the combination of all factors affecting salmon in the Lake Washington system could ultimately result in reduced salmon populations.

Similarly, the potential for spawning ground competition or redd superimposition from the release of up to 17 million additional sockeye fry to result in biologically significant impacts is considered to be very low, but the combination of all factors affecting salmon in the Lake Washington system could ultimately result in reduced Chinook salmon populations. Several environmental conditions occur within the Cedar River that are beyond the control of hatchery managers and have a potential to affect Chinook egg and fry survival. These factors include scour from flooding, low water levels that might dewater Chinook redds, streamside developments that increase the amount of fines in the spawning gravel, siltation due to development activity, bank hardening that reduces the recruitment of spawning gravels, and increases in water temperature.

While each of these factors appears to individually play a relatively minor role in the overall potential for the long-term sustainability of salmon in the Lake Washington system, the cumulative effect of these factors could become additive and result in more significant impacts. For example, the current level of predation, which is not likely to increase measurably due to the release of additional sockeye fry, could become more of a concern if there were genetic impacts as a result of domestication that decreased the ability of juvenile fry to avoid predators. If domestication selection within the Cedar River increased the tendency of Cedar River fish to stray, this could increase the potential genetic impact on Bear Creek sockeye as a result of straying.

The density-dependent nature of many of these potential impacts could have a mitigating effect that would limit the likelihood of all of these factors occurring in concert. For example, if genetic impacts resulted in lowered fitness, and therefore lower adult returns to the Cedar River, straying, superimposition, and spawning ground competition would be less of a concern.

Chapter 4
References

Beauchamp, D.A. 1996. *Modeling the Carrying Capacity for Zooplanktivorous Fishes in Lake Washington.* Final Report to Washington Department of Fish and Wildlife. Olympia, WA.

Beauchamp, D.A., S.A. Vecht, and G.L. Thomas. 1992. Seasonal, diel, and size-related food habits of cutthroat trout in Lake Washington. *Northwest Science* 66:149-159.

Beauchamp, D.A., C. Sergeant, M.M. Mazur, J.M. Scheuerell, D.E. Schindler, M.D. Scheuerell, K.L. Fresh, D.E. Seiler, and T.P. Quinn. 2004. Temporal-spatial dynamics of early feeding demand and food supply of sockeye salmon fry in Lake Washington. *Transactions of the American Fisheries Society* 133(4):1014-1032.

Bentzen, P., and I. Spies. 2000. *Investigation of Genetic Variability Within and Between Lake Washington Sockeye Salmon Populations Using Microsatellite Markers.* Draft Report submitted to SPU. Seattle, WA.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 in W.R. Meehan (ed.), *Influences of Forest and Rangeland Management on Salmonid Fishes in their Habitats.* American Fisheries Society, Special Publication 19, Bethesda, MD.

Brannon, E., D. Amend, M. Cronin, J. Lannan, S. LaPatra, W. McNeil, R. Noble, C. Smith, A. Talbot, G. Wedemeyer, and H. Westers. 2004a. The controversy about salmon hatcheries. *Fisheries* 29(9):12-31.

Brannon, E.L., D.A. Beauchamp, D.E. Campton, C.V.W. Mahnken, and J.R. Winton. 2001. *The Cedar River Sockeye Salmon Hatchery Plan.* Special Scientific Advisory Panel to the City of Seattle.

Brannon, E., M. Powell, T. Quinn, and A. Talbot. 2004b. Population structure of Columbia River Basin Chinook salmon and steelhead trout. *Reviews in Fisheries Science* 11(1):1-120.

Burton, K., L. Lowe, and H. Berge. 2003. *Cedar River Chinook Salmon* (Oncorhynchus tshawytscha) *Redd Surveys and Carcass Assessments: Annual Report 2002.*

Burton, Karl, Seattle Public Utilities, personal communication. Participant at SPU worst case workshop, April 29, 2004.

Crisp, D.T., and P.A. Carling. 1989. Observations of siting, dimensions and structure of salmon redds. *J. Fish. Biol.* 34:119-134.

Devries, P. 1997. Riverine salmonid egg burial depths: Review of published data and implications for scour studies. *Canadian Journal of Fisheries and Aquatic Sciences* 54:1685-1698.

Foley, Steve. Washington Department of Fish and Wildlife, personal communication, 2004. Participant at SPU worst case workshop, April 29, 2004.

Fresh, K.L., S.L. Schroder, E.C. Volk, and J.J. Grimm. 2001. *Straying by Cedar River Hatchery-Produced Sockeye Salmon to Big Bear Creek, WA.* Report by Washington Department of Fish and Wildlife to the Cedar River Sockeye Salmon Technical Committee.

Fresh, K.L., S. L. Schroder, E. C. Volk, J. J. Grimm, and M. C. Mizell. 2003. *Evaluation of the Cedar River Sockeye Salmon Hatchery: Analyses of Adult Otolith Recoveries.* Washington Department of Fish and Wildlife report, 42 p.

Gustafson, R.G., T.C. Wainwright, G.A. Winans, F.W. Waknitz, L.T. Parker, and R.S. Waples. 1997. *Status Review of Sockeye Salmon from Washington and Oregon.* U.S. Department of Commerce, NOAA Tech. Memo. NMFS-NWFSC-33.

Hall, J., and R. Wissmer. 2004. Habitat factors affecting sockeye salmon redd site selection in off-channel ponds of a river floodplain. *Transactions of the American Fisheries Society* 133:1480-1496.

Hendry, A.P., and T.P. Quinn. 1997. Variation in adult life history and morphology among Lake Washington sockeye salmon (*Oncorhynchus nerka*) populations, in relation to habitat features and ancestral affinities. *Canadian Journal of Fisheries and Aquatic Sciences* 54: 75-84.

Hendry, A.P., T.P. Quinn, and F.M. Utter. 1996. Genetic evidence for the persistence and divergence of native and introduced populations of sockeye salmon (*Oncorhynchus nerka*) within Lake Washington, WA. *Canadian Journal of Fisheries and Aquatic Sciences* 53: 823-832.

HSRG (Hatchery Scientific Review Group). April 2004a. *Hatchery Reform: Principles and Recommendations of the HSRG.* L. Mobrand (chair), J. Barr, L. Blankenship, D. Campton, T. Evelyn, C. Mahnken, P. Seidel, L. Seeb and B. Smoker. Long Live the Kings, Seattle, WA. Available at www.hatcheryreform.org.

HSRG (Hatchery Scientific Review Group). April 2004b. *Hatchery Reform in Washington State: Principles and Emerging Issues.* L. Mobrand (chair), J. Barr, L. Blankenship, D. Campton, T. Evelyn, C. Mahnken, P. Seidel, L. Seeb and B. Smoker. Long Live the Kings, Seattle, WA. Available at www.hatcheryreform.org.

Jordan, D.S, and E.C. Starks. 1895. The fishes of Puget Sound. *Proc. Calif. Acad. Sci.* 5:785-855.

Koehler, M.E. 2002. *Diet and Prey Resources of Juvenile Chinook Salmon Rearing in the Littoral Zone of an Urban Lake.* Master of Science Thesis. University of Washington. Seattle, WA.

Labelle, M. 1992. Straying patterns of coho salmon *(Oncorhynchus kisutch)* stocks from southeast Vancouver Island, British Columbia. *Canadian Journal of Fisheries and Aquatic Sciences* 49:1843-1855.

Mazur, M.M. 2004. *Linking Visual Foraging with Temporal Prey Distribution to Model Trophic Interactions in Lake Washington.* Dissertation. University of Washington, Seattle, WA.

McIsaac, D.O. 1990. *Factors Affecting the Abundance of 1977-1979 Brood Wild Fall Chinook Salmon* (Oncorhynchus tshawytscha) *in the Lewis River, Washington.* Ph.D. dissertation. University of Washington, Seattle, WA.

Murray, C., and D. Marmorek. 2003. *Adaptive Management: A Science-Based Approach to Managing Ecosystems in the Face of Uncertainty.* Presented to Fifth International Conference on Science and Management of Protected Areas: Making Ecosystem Based Management Work, Victoria, British Columbia, May 11-15, 2003.

Nowak, G., R. Tabor, E. Warner, K. Fresh and T. Quinn. 2004. Ontogenetic shifts in habitat and diet of cutthroat trout in Lake Washington. *North American Journal of Fisheries Management* 24(2): 624–635.

Peterman, R.M., and M. Gatto. 1978. Estimation of functional responses of predators on juvenile salmon. *Journal of the Fisheries Research Board of Canada* 35:797-808.

Quinn, T.P. 1993. A review of homing and straying of wild and hatchery-produced salmon. *Fisheries Research* 18: 29-44.

Quinn, T.P., E.C. Volk and A.P. Hendry. 1999. Natural otolith microstructure patterns reveal precise homing to natal incubation sites by sockeye salmon (*Oncorhynchus nerka*). *Canadian Journal of Zoology* 77: 766-775.

Reisenbichler, R. R. and S. P. Rubin. 1999. Genetic changes from artificial propagation of Pacific salmon affect the productivity and viability of supplemented populations. *ICED Journal of Marine Science* 56: 459-466.

Royal, L., and A. Seymour. 1940. Building new salmon runs. *The Progressive Fish Culturist* Memorandum I-131, No. 52, November-December 1940. Washington, D.C.

Schroder, S, Washington Department of Fish and Wildlife, personal, communication, 2004. Participant at SPU Wworst Cease Wworkshop, April 29, 2004.

Seiler, D. 1994. *Cedar River sockeye salmon fry estimation, Final Report*: June 1994. Washington Department of Fish and Wildlife. Olympia, WA.

Seiler, D. 1995. *Annual Report: Estimation of 1994 Cedar River sockeye salmon fry production.* Washington Department of Fish and Wildlife. Olympia, WA.

Seiler, D. and L. Kishimoto. 1996. *Annual Report: 1995 Cedar River sockeye salmon fry production evaluation program*. Washington Department of Fish and Wildlife. Olympia, WA.

Seiler, D. and L. Kishimoto. 1997a. *Annual Report: 1996 Cedar River sockeye salmon fry production evaluation.* ~~Annual report,~~ Washington Department of Fish and Wildlife.

Seiler, D. and L. Kishimoto. 1997b. *Annual Report: 1997 Cedar River sockeye salmon fry production evaluation.* Washington Department of Fish and Wildlife, Olympia, WA.

Seiler, D., G. Volkhardt, and L. Fleischer. 2005a. *Evaluation of Downstream Migrant Salmon Production in 2003 from the Cedar River and Bear Creek*. Washington Department of Fish and Wildlife FPT 05-01. 69 p.

Seiler, D., G. Volkhardt, and L. Fleischer. 2005b. *Evaluation of Downstream Migrant Salmon Production in 2004 from the Cedar River and Bear Creek.* Washington Department of Fish and Wildlife report FPT 05-05. 65 p.

Seiler, D., G. Volkhardt, L. Fleischer and L. Kishimoto. 2002. 2000 Cedar River sockeye salmon fry production evaluation. Washington Department of Fish and Wildlife Rpt. FPA 02-16.

Seiler, D., G. Volkhardt, and L. Kishimoto. 2001. *1999 Cedar River Sockeye Salmon Fry Production Evaluation.* Science Division Report Number FPA 01-14. Washington Department of Fish and Wildlife, Fish Program.

Seiler, D., G. Volkhardt, and L. Kishimoto. 2003. *Evaluation of Downstream Migrant Salmon Production in 1999 and 2000 from Three Lake Washington Tributaries: Cedar River, Bear Creek, and Issaquah Creek.* Washington Department of Fish and Wildlife, Fish Program.

Spies, I. 2002**.** *The Origin of Sockeye Salmon* (Onchorhynchus nerka) *in the Lake Washington Watershed, Washington State: A Reappraisal Based on Microsatellite Data.* M.S. thesis. University of Washington, School of Aquatic and Fisheries Science, Seattle, WA.

SPU (Seattle Public Utilities). 2003. *Cedar River Sockeye Hatchery Project Final EIS.* March 2003. Seattle, WA.

State Department of Fisheries and Game. 1932. *Fortieth and Forty-First Annual Reports of State Department of Fisheries and Game, Division of Fisheries, for the Period from April 1, 1929 to March 31, 1931. Fiscal Years of 1929 and 1930.* Charles R. Pollock, State Supervisor of Fisheries, Olympia, WA.

Steen, R.P. and T.P. Quinn. 1999. Egg burial depth by sockeye salmon *(Oncorhynchus nerka)* implications for survival of embryos and natural selection of female body size. *Canadian Journal of Zoology* 77:836-841.

Tabor, R., J. Chan, and S. Hager. 1998. *Predation of Sockeye Salmon Fry by Cottids and Other Predatory Fishes in the Cedar River and Southern Lake Washington, 1997.* U.S. Fish and Wildlife Service, Western Washington Office, Aquatic Resources Division. Lacey, WA.

Tabor, R.A., M.T. Celedonia, F. Mejia, R.M. Piaskowski, D.L.Low, B. Footen, and L. Park. 2004. *Predation of Juvenile Chinook Salmon by Predatory Fishes in Three Areas of Lake Washington Basin.* Miscellaneous Report. U.S. Fish and Wildlife Service, Western Washington Office. Lacey, WA.

Unwin, M.J., and T.P. Quinn. 1993. Homing and straying patterns of chinook salmon (*Oncorhynchus tshawytscha*) from a New Zealand hatchery: Spatial distribution of strays and effects of release date. *Canadian Journal of Fisheries and Aquatic Sciences* 50: 1168-1175.

Chapter 5
Glossary

Adaptation:	The process or result of adapting to a new temperature, altitude, climate, environment, or situation. This process often involves evolutionary changes.
Adaptive Management Plan:	A framework that is designed to avoid, minimize, and mitigate potential adverse environmental effects of a project that may have significant uncertainties. An Adaptive Management Plan identifies areas of uncertainty and how project proponents would identify and respond to those uncertainties as the project progresses.
Adfluvial Fish:	Species that rear as adults in a lake and spawn in a river or tributary to a river.
Alevin:	The life stage of fish that occurs after hatching. Alevins are newly hatched fish with attached yolk sacs; the stage ends when the yolk is entirely absorbed and the free-swimming fish is called a fry.
Anadromous Fish:	Species, such as salmon, which are spawned in fresh water, spend a large part of their lives in the sea, and return to fresh water rivers and streams to spawn.
Bedload Movement:	Downstream movement of silt, sand, coarse-grained gravels, and cobbles in a river or stream.
Benthic:	Living on the bottom of a body of water.
Broodstock:	Adult fish used for breeding in a hatchery.
Composite Stock:	A fish stock where fish raised in a hatchery and naturally spawning fish are managed as a single population.
Daphnia:	A genus of crustacean zooplankton that is important in the Lake Washington food web.
Disease-Free Water:	In the context of the proposed sockeye hatchery project, a water supply that is free of IHN virus and other agents that may be harmful to incubating eggs or fry, especially in the hatchery environment.
Diversity:	In ecology, the number of species of plants and animals within a defined area. Diversity is measured by a variety of indices that consider the number of species and, in some cases, the relative abundance among species.

Domestication:	The process by which hatchery operations or management decisions result in the production of fish that have traits that make them more adapted to a hatchery environment, but less adapted to the natural environment. The process might result from deliberate or inadvertent selection.
Environmental Impact Statement (EIS):	A document prepared under the State Environmental Policy Act to systematically analyze the effects proposed actions will have on the environment.
Fecundity:	The number of eggs produced at maturity by a female fish.
Fitness:	See reproductive fitness.
Food Web:	The predator-prey relationships between various organisms in a given ecosystem.
Fry:	A free-swimming, juvenile salmonid that has recently emerged from the gravel and has fully absorbed its yolk sac.
Gene:	The basic unit of inheritance. Genes play a fundamental role in determining the nature of cell substances, cell structures, and cell effects. Genes have properties of self-perpetuation and variation.
Genetic Diversity:	The overall variation of genes that are possible within an entire population at a given time, commonly referred to as the "gene pool." The more genetic variation there is in a population, the better the chance that at least some individuals will have a trait that would allow them to survive and reproduce under a stressful condition in the future.
Habitat Conservation Plan (HCP):	As defined under Section 10 of the federal Endangered Species Act, a plan required for issuance of an incidental take permit for a listed species. HCPs can address multiple species, both listed and unlisted, and can be long term. HCPs provide for the conservation of the species addressed, and provide certainty for permit applications through an implementation agreement between the Secretary of the Interior or Secretary of Commerce and a non-federal entity.
Habitat:	The specific area or environment in which a particular type of plant or animal lives.
Homogenization:	The process by which two or more genetically distinct populations are transformed into a single mixed population. The effects of homogenization are similar to the effects of straying, but they may occur within the various subpopulations or distinct reproducing groups of a single river or stream system (such as the Cedar River) rather than being spread across an entire basin (such as the Lake Washington basin).
Implementation Agreement:	A part of the application for an incidental take permit for an approved HCP; an agreement that specifies the terms and conditions, resources, schedule or activities, and expectations for the parties to the agreement.
Incubation:	The process by which fertilized eggs grow and differentiate.

Incubators:	Structures used for artificially incubating fertilized eggs.
Infectious Hematopoietic Necrosis (IHN) Virus:	A viral pathogen present in nearly all populations of sockeye salmon, and some populations of steelhead trout and Chinook salmon, which causes the potentially fatal disease infectious hematopoietic necrosis.
Invertebrates:	Animals without backbones.
Mainstem Habitat:	Habitat in larger river channels (as opposed to habitat in smaller tributaries).
Marked Fry:	See otolith marking.
Migration Barrier:	A barrier across a stream, such as a dam, culvert, or a natural waterfall, that prevents fish from migrating up or downstream.
Mitigation:	Under SEPA, mitigation is defined as the use of any or all of the following measures: avoiding the impact altogether by not taking a certain action or parts of an action; minimizing impacts by limiting the degree or magnitude of the action or its implementation by using appropriate technology or by taking affirmative steps to avoid or reduce impacts; rectifying the impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation or maintenance operations during the life of the action; compensating for the impact by replacing, enhancing, or providing substitute resources or environments; monitoring the impact and taking appropriate corrective measures (SEPA, WAC 197-11-768).
Mortality:	Death of individuals within a given population.
Natal System:	In the context of this project, the system into which a fish emerges, and to which it is likely to return at maturity.
Natural Selection:	Darwin's theory of evolution according to which organisms tend to produce more offspring than can be supported and, in the struggle for existence that ensues, only those offspring with favorable variations survive.
Otolith Marking:	Thermal otolith marking is accomplished by artificially creating a fairly rapid change in water temperature within the incubators of approximately $4^{o}C$ (either higher or lower), over a period of 8 to 24 hours. This induces bands on the otoliths (inner ear bones of the fish) that can be detected under a microscope.
Outmigration:	The process of juvenile fish migrating from one rearing environment to another.
Parties:	In the context of this project, the Parties to the Landsburg Mitigation Agreement, which include the Washington Department of Fish and Wildlife, U.S. Fish and Wildlife Service, NOAA Fisheries (formerly referred to as National Marine Fisheries Service (NMFS)), and City of Seattle.

Phenotypic Traits:	Observable traits or characteristics of an organism.
Planktivorous Fish Species:	Fishes that eat plankton (small plants and animals that drift in water).
Redd:	The nesting site created by female salmon and trout, consisting of a series of discrete egg pockets buried beneath the surface of the stream or lake. The redd is formed by the digging action of the female fish.
Reproductive Fitness:	The ability of spawning fish to produce offspring that survive to successfully reproduce.
Salmonids:	All members of the family Salmonidae, which includes the genus *Oncorhynchus*, including species whose common names are Chinook, steelhead, coho, and sockeye, as well as other genera of closely related fishes.
Scour:	Removal of river substrate by a powerful current of water.
Smolt:	The life stage of a juvenile salmon when it migrates to salt water, involving physiological changes that adapt an individual for the change from fresh to salt water.
Spawn:	When an aquatic animal deposits or releases eggs or sperm.
Spawning Channel:	A constructed side channel, replicating natural conditions for salmonid spawning. Typically constructed as a form of mitigation.
State Environmental Policy Act (SEPA):	The state law that requires all state and local government agencies to consider and analyze the adverse environmental impacts of any action proposed by those agencies, to inform and involve the public in the agency's decision-making process, and to consider the environmental impacts in the agency's decision-making process.
Straying:	When salmon returning from the ocean to spawn do not return to the stream or river in which they reared (their natal stream) but rather enter and spawn in a different stream, river, or other spawning area.
Superimposition:	When a salmon digs a redd that overlaps (i.e., is superimposed over) the existing redd of another salmon.
Thresholds:	Limits at which certain actions are triggered.
Turbidity:	A measure of the amount of material, such as silt or organic debris, suspended in water. Increasing the turbidity of water decreases the amount of light that penetrates the water column. High levels of turbidity are harmful to aquatic life. EPA and the Washington Department of Health set standards for turbidity in drinking water.
Watershed:	The geographic region within which water drains into a particular river, stream, or body of water.

Weir:	A fence or enclosure set in a waterway for blocking fish passage or capturing fish.
Zooplankton:	Small animals that drift or swim in water.

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Appendix A – Adaptive Management Plan

Seattle Public Utilities

DRAFT Adaptive Management Plan
Cedar River Sockeye Hatchery

July 2005

Tetra Tech/KCM, Inc.
1917 First Avenue, Seattle, WA 98101-1027

Adaptive Management Plan
Cedar River Sockeye Hatchery
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SECTION 1.
INTRODUCTION

1.1 EXECUTIVE SUMMARY

1.1.1 AMP Purpose and Objectives

This Adaptive Management Plan (AMP) defines an operating and management framework for the Cedar River Sockeye Hatchery Program[1]. This program was developed to address dual objectives of realizing the full potential of the Cedar River to support sockeye while protecting drinking water quality. This AMP includes an initial technical basis for monitoring and evaluation of the Cedar River Sockeye Hatchery. The application of adaptive management to hatchery operations and evaluation is rare; consequently, this AMP relies primarily on the experience of other efforts adapted to the unique challenges of this program. Application of adaptive management to this hatchery program has the potential for achieving unusually high standards for monitoring, evaluation and decision-making.

The primary purpose of the AMP is to help the hatchery program meet its mitigation goals by minimizing risks of long-term adverse impacts through effective monitoring and management. There are two important biological goals for this hatchery program.

- Implement the Cedar HCP and Landsburg Mitigation Agreement commitments related to a biologically and environmentally sound long-term sockeye hatchery program that will help to provide for the recovery and persistence of a well-adapted, genetically diverse, healthy, harvestable population of Cedar River sockeye.
- Avoid or reduce detrimental effects on the reproductive fitness and genetic diversity of naturally reproducing salmon populations in the Cedar River and the Lake Washington basin.

The success of this hatchery program will rely on the ability to integrate artificial and natural production systems to realize the full biological potential of the physical environment. Consequently this AMP focuses on potential risks to naturally spawning salmon, prescribes monitoring activities to detect effects, and establishes a process for analyzing and addressing adverse impacts if they occur. This hatchery program will be deemed a failure if it results in a substantial loss of the ability for naturally reproducing sockeye or chinook to sustain themselves or if it fails to significantly increase sockeye returns to the Cedar River. The proposed hatchery is expected to augment natural spawning on the Cedar River and, if successful, will produce a

[1] This AMP applies to the replacement hatchery. Unless the interim hatchery is specifically mentioned, all references to the hatchery or hatchery program contained in this document apply to the replacement hatchery.

greater and more consistent number of returning adult sockeye than would result without it. This is expected to increase sport and tribal harvest opportunities of the Lake Washington sockeye salmon fishery.

Within this context for the goals of the sockeye hatchery program, the objectives of this AMP are:

1. Address the primary technical uncertainties with respect to performance and effects of the hatchery program
2. Promote a high standard for scientific work so that results are credible
3. Effectively communicate scientific results to managers
4. Provide public access to scientific data
5. Provide opportunity for public input to decision-making process
6. Promote public understanding of decisions
7. Utilize limited monitoring resources effectively and efficiently

Success of the AMP will be determined by the achievement of these objectives over time.

Scientists, hatchery operators and fishery managers, with expertise in hatchery operations and the effects of those operations on other resources, have guided the development of this hatchery program. Their work has resulted in guidelines, operating protocols, capacity analysis and this adaptive management plan that is designed to contribute to the success of the program by producing additional adult returns and by minimizing adverse effects. The adaptive management plan will not direct harvest management actions, for which the fishery co-managers have regulatory authority; however, the AMP will generate valuable information for harvest management.

1.1.2 Challenges of Adaptive Management

Adaptive management is a term whose definition in practice is imprecise. However many adaptive management efforts include similar elements that include defining experiments to test responses of predetermined variables and applying the results to future management decisions. Adaptive management has been applied to projects and programs of various sizes. Generally, the more complex the program or range of potential variables that are affected by a specified action, the more difficult it is to determine causal relationships and to use monitoring results to make appropriate management responses. Thus, too much complexity makes it difficult to apply adaptive management. Nevertheless, establishing a monitoring program that provides relevant information, even if that information is not fully conclusive, still provides a better basis for professional judgment than no information at all. Therefore, the adaptive management decision-making process must respond to various inputs, ranging from recommendations based on statistically certain results to those based on expert judgment informed by the available information. Adaptive management is used to learn about ecosystems as well as to control risk of adverse effects of specific

projects. By defining key uncertainties associated with impacts or results of the project, adaptive management encourages collection of appropriate data that are needed to evaluate the project. These results are reviewed by scientists, who provide technical advice to a decision-making body that ultimately determines if program changes should be made to reach its objectives.

Experience with adaptive management has resulted in mixed results. The concept has proved useful for providing a structure that allows people with differing perspectives to agree to allow controversial natural resource actions to proceed, while working together to develop a greater understanding of the results and effects. At the same time, and in many cases, adaptive management has been challenged to fully integrate scientific input into management decisions. Also, some believe that adaptive management has failed to force hard decisions by managers, in spite of scientific results that support these decisions.

A key goal of adaptive management is to encourage accountability and transparency in decision-making. Scientific data, analyses and recommendations are intended to form key input to management decisions through adaptive management. Consequently, the quality of scientific work needs to be sufficient to be generally accepted and not in itself a source of significant uncertainty. Peer review of proposals and reports, involvement by independent scientists, statistical evaluation of research proposals and timely access to data are important ways of improving the credibility of scientific results.

1.1.3 Development of This AMP

This AMP is a requirement of the Cedar River Habitat Conservation Plan and the Landsburg Mitigation Agreement (LMA) and is to be in place prior to beginning operations of the hatchery. In early 2000 the City of Seattle assembled a special scientific advisory panel as called for in the LMA. This panel was established to advise the City of Seattle and the other Parties to the LMA in developing plans for an effective, comprehensive, and biologically sound artificial propagation program consistent with the Habitat Conservation Plan. The panel included experts in sockeye biology, Lake Washington ecology, fish diseases, genetics and recent hatchery reform initiatives. They came from University of Idaho, University of Washington, U.S. Fish and Wildlife Service, National Marine Fisheries Service and U.S. Geological Survey. The science panel developed guiding principles for the hatchery embodied in *The Cedar River Sockeye Salmon Hatchery Plan* (Brannon et al., 2001). Recommendations from this document have been used to develop further program documents, including the AMP. The science panel reviewed the status and factors affecting sockeye in the Cedar/Lake Washington basin and recommended monitoring and research needs. The AMP is responsive to these recommendations. The hatchery plan provides guidelines for improving survival of hatchery releases and minimizing adverse interactions between hatchery and wild fish.

The development of the proposed AMP for the sockeye hatchery involved research into past and current efforts to implement adaptive management by others. No examples of the detailed application of adaptive management to hatchery operations were found in the literature; however, there were examples of the use of adaptive management in

other natural resource applications. In addition to information gathered from this literature review, the Cedar River Sockeye Hatchery AMP relies on information gathered from two adaptive management workshops, sponsored by Seattle Public Utilities (SPU) and Washington Trout in 2001 and 2002. Regional and national experts were brought together to discuss the challenges and lessons learned from previous efforts to develop and implement adaptive management programs. This exchange of ideas and experiences provided guidance concerning how the AMP decision-making process should be structured to achieve AMP objectives.

Tetra Tech/KCM Inc. was contracted to develop the proposed Adaptive Management Plan. This effort involved various technical experts in salmon biology, hatchery issues, genetics, and sockeye salmon culture. The AMP for the Cedar River Hatchery was further developed by a group of select scientists, led by Dr. Tom Quinn, U. of Washington. An earlier version was reviewed by the Cedar River Anadromous Fish Committee (AFC), the advisory committee comprised of scientists and stakeholders established in the LMA to provide advice and consultation to the City concerning the implementation of the LMA. AFC membership currently includes City of Seattle, WDFW, NOAA Fisheries, U.S. Fish and Wildlife Service, Muckleshoot Indian Tribe, Trout Unlimited, Puget Sound Anglers, Washington Trout, King County, Long Live the Kings and the public at-large. Comments from committee members were reviewed by the authors. These comments included questions regarding the level of certainty associated with the effects of domestication selection; assumptions about fry survival rates; how future production levels would be established; whether measurements of fry to adult survival were meaningful assessments of fitness; and the need to establish clear thresholds and responses.

More recently, SPU has sought comment from Dr. Barry Gold, a recognized national expert in adaptive management (Dr. Gold led the adaptive management program for the Glenn Canyon Dam project). The Hatchery Science Reform Group (HSRG) reviewed the Cedar River sockeye hatchery, including the earlier version of the proposed AMP. The HSRG was established by Congress in FY 2000 to ensure that hatchery reform programs in Puget Sound and Coastal Washington are scientifically founded and evaluated; that independent scientists interact with agency and tribal scientists to provide direction and operational guidelines; and that the system as a whole be evaluated for compliance with scientific recommendations (further information on members of the HSRG can be obtained at www.longlivethekings.org/HRP_HSRG.html).

The AMP will be presented to the parties of the LMA for their acceptance after the State Environmental Policy Act (SEPA) process is concluded.

1.1.4 Key Features of this AMP

The Cedar River Hatchery Adaptive Management Plan includes a discussion of five key areas of uncertainty and describes the structural framework that guides scientific work as well as decision-making. The key uncertainties are as follows:

- Comparability between fry produced by the hatchery and in the river
- Effects on reproductive fitness in naturally spawning sockeye
- Effects on sockeye populations outside the Cedar River

- Effects on Cedar River chinook
- Effects on the aquatic community in Lake Washington.

The discussion of each of these uncertainties includes potential hypotheses, criteria, results and responses. The Plan is intended to be flexible and to be adjusted over time as necessary to reflect current knowledge or experience.

This plan includes an organizational framework (see Section 4) that is intended to promote credible scientific input and informed decision-making. The ultimate decision-making body is made up of representatives from the four Parties to the LMA: the City of Seattle, the U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration (NOAA) Fisheries and the Washington Department of Fish and Wildlife. Under the LMA, the parties are committed to using adaptive management to address critical questions as they arise and make changes in management based on the results of monitoring to meet the specific objectives of the hatchery program. The parties receive advice directly from the Adaptive Management Work Group (AMWG) and will have access to recommendations from the scientist panels as well. The AMWG will include agency scientists and stakeholders. This group will be advised by the Independent Science Advisors (ISA), the Technical Work Group (TWG) and the Monitoring and Research Parties. Each group has a specific role as will be described below.

This structure is intended to promote~~allow~~ the development of sound scientific direction that will help the decision-makers to manage the hatchery program. Considerable emphasis will be placed on measures needed to ensure that the appropriate monitoring data are collected in a scientifically and statistically sound manner so that results address key outstanding uncertainties. For example, the productivity of Cedar River sockeye and chinook will continue to be monitored to evaluate whether changes are occurring.

The fry production level for this hatchery is capped at 34 million fry, roughly double the hatchery capacity provided by the interim hatchery facility. The interim hatchery has operated since 1991 and the production levels have generally trended higher over time.

The actual operating target level will be established annually by the parties to the LMA, based on factors including, but not limited to: 1) an assessment of the risk of irreversible harm; and 2) the goal, established in the Capacity Analysis, that over the long term and on average, hatchery returns will contribute no more than 50 percent of the overall sockeye return to the Cedar River. The assessment of risk will be a synthesis of monitoring results and analyses of the effects of the hatchery program in the key areas of uncertainty. Predefined thresholds will be established where possible, to aid in identifying levels where results would suggest that effects should be critically reviewed and action considered or implemented. Thus, setting the annual production goal for the hatchery is one of the primary outcomes of the adaptive management process. Results from adaptive management will also be used to improve returns as results from various culture strategies are learned and applied.

Key uncertainties reflect those issues that have special importance in terms of potential effects. On example is the special emphasis the hatchery program places on maintaining the reproductive fitness of naturally spawning sockeye in the Cedar River. Maintaining the productivity of natural spawning sockeye is critical to producing the larger salmon returns that are needed to hold more frequent fisheries, one measure of success. To do so means protecting the productivity of the sockeye population that spawns in the river over the long term. There are no studies that have examined the effects of a sockeye fry hatchery on reproductive fitness of a composite stock comprised of returns that have varying levels of hatchery and natural spawning influence. Consequently the adaptive management program identifies the maintenance of reproductive fitness in Cedar River sockeye as a key uncertainty and directs monitoring to measure productivity of natural spawners over time. This program represents significant opportunity to study hatchery effects and contribute to a broader understanding of this issue.

To further reduce risk and to reinforce the fact that this program is intended to supplement, not detract from natural production of sockeye in the Cedar River, a unique goal of this hatchery is to adjust egg collection goals so that overtime and after an initial start up period, the return of naturally produced sockeye will be at least 50 percent of the total return. Thus, if natural productivity declines, hatchery production would decline as well. This quantitative goal is discussed in the Capacity Analysis section of the Program Documents and is intended to place heightened awareness on the need to maintain or improve the health of both naturally spawning sockeye and their habitat. This pioneering connection between hatchery and natural production is intended to help to avoid the replacement of naturally- produced sockeye with hatchery returns. Maintaining an upper limit of 50 percent hatchery origin in the return means that a significant portion of returns will have been subjected to the full range of selection pressures by spawning naturally. It also means that substantial numbers of sockeye used for broodstock in the hatchery will be of natural origin, which some believe will likely improve the fitness of the hatchery-origin sockeye as they return and spawn in the river. The proposed long-term maximum for hatchery-produced returns will be evaluated through monitoring and adaptive management and could be adjusted in the future.

1.1.5 AMP Implementation

Monitoring activity associated with the interim sockeye hatchery program, while not directed by the adaptive management plan, has been ongoing since the early 1990's. Results from this work are being used to guide the project through the oversight of the Cedar River Anadromous Fish Committee and the Parties to the Landsburg Mitigation Agreement. These data provide baseline information about the existing level of sockeye production and about the other salmonid populations and Lake Washington ecosystem. The AMP process will need to evaluate information that has been collected to date regarding effects of the interim hatchery as well as to establish future direction for the monitoring and evaluation elements as the replacement hatchery begins operation. There are known limitations associated with the interim hatchery that are being addressed in the design of the replacement hatchery. This adds complexity to the evaluation of the replacement hatchery, but also provides opportunity for insight into cause and effect relationships (eg. size of returning females). The operation of the

interim hatchery could have resulted in changes that are the subject of monitoring and evaluation under this adaptive management program. Thus, it will be important to consider baseline conditions as both pre-hatchery and interim hatchery, as appropriate, when considering reference conditions for the evaluation of impacts. In some cases, the availability of baseline information my limit comparisons with pre-hatchery or interim hatchery conditions.

While the Cedar River Hatchery is not scheduled to be completed and operating until 2007, the AMP implementation schedule (see Section 4) calls for AMP activity to begin in 2005. The parties, with the advice of the Adaptive Management Work Group, will oversee the recruitment of the Technical Work Group as well as the development of a list of independent scientific advisors. Once the key groups are formed and operating parameters defined, a review of the AMP will occur in 2006. The primary purpose is to ensure that the people that will be involved with the implementation of the AMP have the opportunity for input. In particular, the TWG and the AMWG will be asked to evaluate the list of uncertainties, identify specific hypotheses for testing, review the monitoring program, and review and further develop criteria, thresholds and responses prior to implementation. Changes to this plan are expected at this point as those who will be working on this program apply their knowledge and expertise. Specificity in setting thresholds for specific criteria provides greater assurance of response when these are exceeded. Pre-determined responses will be identified and may be either changes to the hatchery program or initiation of a conscientious evaluation of the situation that may lead to an action as defined by the adaptive management process.

Much emphasis is being placed on the importance of reforming hatchery practices so that effects on natural populations are minimized. The adaptive management plan serves to address a common concern that many hatchery programs lack sufficient evaluation. Proper evaluation needs to document natural and hatchery contributions to adult returns as well as examine key areas where the hatchery program may be having adverse effects. The long-term commitment to monitoring associated with this hatchery is unusual and provides a basis of support for the AMP. Its implementation and success will rely on the cooperation of scientists, agencies and stakeholders to participate with objectivity and commitment to the goals of the program.

1.2 BACKGROUND

Adaptive management is an approach that incorporates monitoring and research to allow projects and activities, including projects designed to produce environmental benefits, to go forward in the face of some uncertainty regarding their consequences (Holling 1978; Walters 1986). In the adaptive management process, high priority is placed on learning about the subject ecosystem; in order to learn, management policies are designed as experiments to probe ecosystem responses (Lee 1999). Two essential characteristics of effective adaptive management are a direct feedback loop between science and management, and the view of management as an experiment (Halbert 1993).

The ecology of sockeye in the Lake Washington system is not completely understood and the effects of a Cedar River Sockeye Hatchery program on the Cedar River sockeye

population, other Lake Washington basin sockeye populations, other basin salmonid populations, and the Lake Washington ecosystem as a whole are not fully predictable. The adaptive management approach was chosen as a hatchery management tool to allow better understanding of the performance and effects of the hatchery and promote effective management responses to new information. Adaptive management of the hatchery is intended to increase knowledge about the Lake Washington system and provide the flexibility to incorporate that knowledge into hatchery operations to avoid or minimize adverse impacts on the ecosystem.

The general adaptive management process is illustrated in Figure 1-1. Hypotheses are formulated in advance regarding important uncertainties. As the project begins its operation, data are collected to address the uncertainties. The results from the monitoring studies are then used to evaluate the hypotheses with respect to the project's goals. If a monitoring study finds that a threshold has been exceeded or that project goal is not being met (e.g., there are impacts on other salmon in the ecosystem due to hatchery operations), then the parties can decide to make modifications to reduce or avoid such impacts. Monitoring then continues to evaluate the success or failure of the response action, and to address new hypotheses that may be formulated as new issues arise.

While common concerns apply to most hatcheries in varying degrees, each program is unique and requires a customized evaluation program. The major uncertainties presented in this document are specific to the Cedar River Sockeye Hatchery and its operations. The concerns and uncertainties are likely to change over time as questions are answered and new ones become apparent. The results of studies need to be incorporated into the operation of the hatchery to be as successful as possible in meeting the dual objectives of producing returns and limiting impacts. Dr. Robert Naiman of the University of Washington has pointed out a series of steps leading to wise decisions. Samples or other forms of data must be collected, then analyzed to produce information, then interpreted to produce knowledge, then tempered with experience and judgment to produce wisdom. The successful operation of the hatchery will depend on this sequence of steps being unbroken.

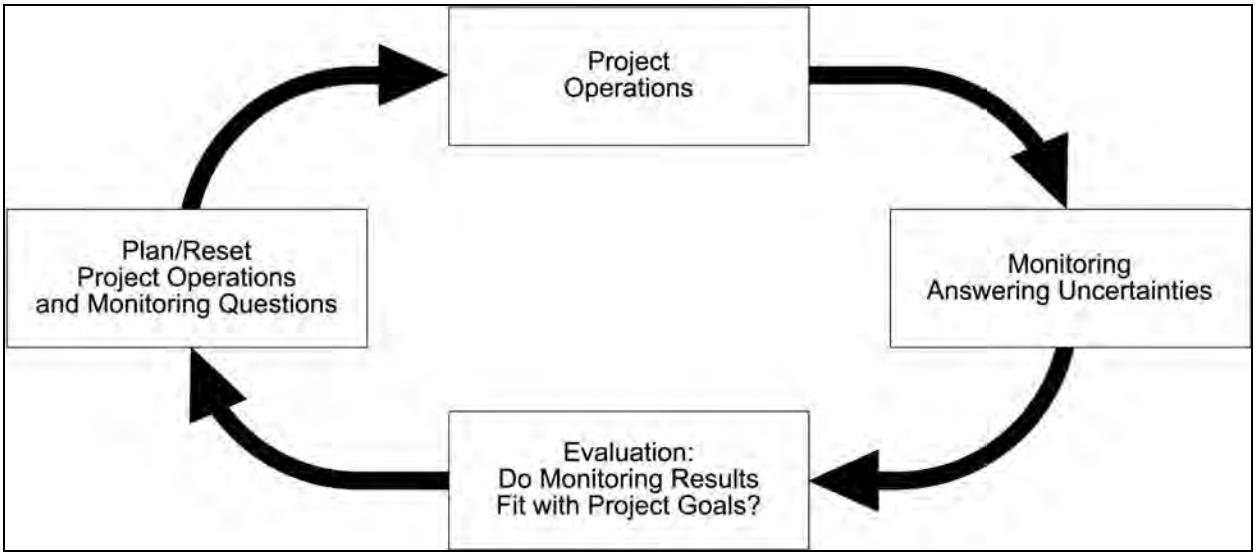


Figure 1-1. General Overview of the Adaptive Management Process

This document identifies only key uncertainties specific to the Cedar River Sockeye Hatchery, not the routine uncertainties that would be encountered in any hatchery program. The key uncertainties are those requiring a higher level of monitoring and research than has typically been available for hatchery programs. For each uncertainty, sections are presented addressing the following topics:

- **Definition and Importance**—This section defines the uncertainty and identifies its importance as it relates to the hatchery goals of producing fry and avoiding adverse ecological impacts.
- **Existing Data and Knowledge**—This section describes past and current research in the Lake Washington basin related to the uncertainty. Efforts were made to adequately represent all research and knowledge that was accessible and available.
- **Remaining Unknowns**—This section describes the ecological issues about which little is known. The unknowns covered are primarily those that have relevance for hatchery operations and meeting project goals.
- **Hypotheses**—This section presents priority hypotheses to be studied during initial project operation.
- **Monitoring and Research Plan**—This Adaptive Management Plan (AMP) has been prepared based on information available at a particular point in time. The results of studies underway may allay some of the concerns or heighten others. A proposed research and monitoring program has been outlined; final determination of the elements of the program will be made as part of the formal adaptive management process. This section provides an overview of how each hypothesis identified in the previous section should be studied. Contracted researchers will develop detailed study plans at a later date. Detailed study plans will include a power analysis when appropriate, which specifies necessary sample sizes, minimum detection levels, and appropriate significance levels so that there is confidence in study results and the ability to make management decisions based on them. This section identifies recommended study durations; however, studies could be continued or discontinued depending on initial study results and guidance of the technical work group. This section also includes a budget for investigation of these hypotheses (in 2001 dollars). The budget allocations in this document focus on the first 10 years of operation and could shift over time as knowledge is gathered.
- **Adaptive Management Actions**—This section describes potential outcomes for each monitoring and research hypothesis. For each outcome, potential management responses are listed. These responses are recommended strategies that could reconcile project operations with the project goals. However, the recommended strategies are subject to change as more information or different technologies become available. Ultimate management responses will be decided through the management process, as described in Section 4.

1.3 SUMMARY

This Adaptive Management Plan presents a technical discussion of the five major uncertainties in Section 2. The information for each uncertainty is then summarized in Section 3 of this document. The last section presents a strategy, principles, organization and decision process for the AMP.

This document is offered as a basis for discussions between appropriate parties to reach agreement on management roles and relationships and the responsibilities and authorities of participants. It has been prepared with the following goals:

- To provide a starting point for initiating the required research and monitoring of the ecosystem
- To establish an evaluation and management process to respond effectively with the full range of issues that may arise within the context of the hatchery program.

SECTION 2.
KEY UNCERTAINTIES

The proposed Cedar River Sockeye Hatchery is designed to increase the average number of Cedar River sockeye salmon and to minimize or avoid adverse effects on the following:

- The existing sockeye population in the river
- Other sockeye salmon populations in the Lake Washington system
- Salmonid species in the basin
- The overall health of the Lake Washington ecosystem.

There is sufficient experience with hatcheries elsewhere to justify concern about these effects, though it is far from certain that they will occur. In this AMP, key areas of uncertainty are defined so that hypotheses can be constructed and tested through monitoring and evaluation. Information generated from this process will provide a basis for scientific evaluation and ultimately serve as the basis for changing the program to better meet project goals. Uncertainties and hypotheses are expected to change over time as questions are answered and new ones emerge. Five major uncertainties are presented below.

2.1 UNCERTAINTY NO. 1—ARE HATCHERY AND NATURALLY PRODUCED FRY SIMILAR IN SIZE, GROWTH, AND MIGRATION TIMING, AND AT A STABLE POPULATION COMPOSITION?

2.1.1 Definition and Importance

Until recently, the Cedar River population was composed of wild sockeye salmon. Since operation of the interim hatchery began, it has been composed of both hatchery and naturally produced sockeye. The intent is to maintain the natural attributes of this composite population so that fish of both origins can spawn successfully in the river. In keeping with this intent, there is a stated objective to keep naturally and hatchery produced fry "comparable." Here, the term "fry" refers to individuals who have absorbed their yolk and either emerged from the gravel volitionally or have been released from the hatchery. Due to the difference between hatchery conditions and those in the river incubation environment, there is concern that the hatchery fry might differ from their naturally produced counterparts. The differences would be important if hatchery fry exhibited a handicap or an advantage compared with natural fry that could lead to shifts in the composite nature of the sockeye population and ultimately, affect the fitness of the sockeye population that spawns in the river.

The definition of "comparable" can be applied in many ways. For this AMP, it is important to use qualities that can be quantitatively compared, and can provide a basis for conclusions about similarities between hatchery and naturally produced fry. Comparisons of size, growth, and migration timing of the two groups of fry are instructive because they influence survival rates and can be examined in a way to produce statistically strong results. In addition, it is possible to track the composition

of the fry population to ensure that a balance of natural and hatchery fish is maintained.

The interpretation of the results of comparisons between hatchery and naturally produced fry needs to recognize the potential factors that may influence differences. For example, fry to adult survival rates can be influenced by emergence and release location, flow, feeding, time of day of release or emergence, time of year and other factors as well as by genetic influences. Comparisons that are influenced by as few variables as possible are more likely to lead to more accurate interpretations of cause and effect than those where many potential variables may influence results. Due to the number of variables potentially affecting results, comparisons of fry to adult survival are not a useful method for evaluating relative fitness between hatchery and natural fry. Fry to adult survival rates will be calculated and compared, however, in the effort to better understand factors affecting survival in general.

2.1.2 Existing Data and Knowledge

Research on hatchery and naturally produced sockeye salmon has been conducted at several juvenile stages. These stages include the fry stage when the fish are migrating out of the Cedar River into Lake Washington, the "pre-smolt" stage when they are in Lake Washington in March or April (about one to two months before they leave for salt water), and the "smolt" stage when the fish are leaving the Lake Washington system and entering Puget Sound through the Hiram Chittenden Locks (locks).

The Washington Department of Fish and Wildlife (WDFW) started sampling fry near the mouth of the Cedar River in 1992, the same year of initial releases from the interim hatchery. The fry-trapping program allows estimation of the number of fry entering the lake from the Cedar River and the natural-hatchery composition of the fry population. Table 2-1 presents the Cedar River fry production estimates and population composition for the 1991-2000 brood years. The hatchery component of the sockeye fry population has varied between 6 and 87 percent since 1991, with an average of 29 percent.

In addition to estimating the fry population, fry trapping can provide~~s~~ information on migration timing and fry size. Migration timing studies have shown that hatchery fry typically reach the lake before naturally produced fry, with the median migration date ranging from 8 to 46 days earlier for hatchery fish. Table 2-2 summarizes the median migration dates for hatchery and naturally produced fry in calendar years 1992 to 2002. The difference in migration timing could be due to factors such as the timing of egg take, the temperature of incubation water, and selective mortality of embryos in the river. Comparison of 2000 egg take timing and the spawning curve indicates that egg take did not occur before spawning in the river in that year (Figure 2-1). Data from 1999 indicated a similar pattern. However, the spawning curve given is based on counts of fish both spawning and migrating within the river and the true spawning time in the river could be later. However, most of the difference in migration timing is thought to be a result of the temperature of the spring water used to incubate eggs in the hatchery, which is slightly warmer than the water in the river.

TABLE 2-1.
CEDAR RIVER FRY ESTIMATES GENERATED FROM THE FRY TRAPPING STUDIES CONDUCTED NEAR THE MOUTH OF THE RIVER

Brood Year	Sampling Year	Total Fry Production	Hatchery Fry (Percent of Total)	Naturally Produced Fry (Percent of Total)
1991	1992	10,400,000	600,000 (6%)	9,800,000 (94%)
1992	1993	28,800,000	1,700,000 (6%)	27,100,000 (94%)
1993	1994	24,700,000	6,600,000 (27%)	18,100,000 (73%)
1994	1995	14,300,000	5,600,000 (39%)	8,700,000 (61%)
1995	1996	5,~~3~~800,000	5,100,000 (87%)	730,000 (13%)
1996	1997	38,300,000	13,900,000 (36%)	24,400,000 (64%)
1997	1998	~~33,000~~32,700,000	7,600,000 (23%)	25,400,000 (77%)
1998	1999	18,500,000	9,000,000 (49%)	9,500,000 (51%)
1999	2000	12,000,000	3,000,000 (25%)	9,000,000 (75%)
2000	2001	52,400,000	14,500,000 (28%)	37,900,000 (72%)
2001	2002	43,600,000	12,000,000 (27%)	31,600,000 (73%)
2002	2003	42,300,000	14,400,000 (34%)	27,900,000 (66%)
2003	2004	47,900,000	9,200,000 (19%)	38,700,000 (81%)
	Average	**~~25~~28,600,000**	**~~7,2~~7,900,000 (28%)**	**~~18,4~~20,700,000 (72%)**

Sources: Seiler 1994; 1995, Seiler and Kishimoto 1996; 1997A; 1997B;Seiler et al 2004A, 2004B, 2005A, 2005B ~~WDFW, unpublished data~~

TABLE 2-2.
MEDIAN MIGRATION DATES OF HATCHERY, NATURALLY PRODUCED, AND COMBINED SOCKEYE FRY IN THE CEDAR RIVER FROM 1992-2004~~2~~

Brood Year	Sampling Year	Median Date			Difference N-H (days)
		Natural	Hatchery	Combined	
1991	1992	3/18	2/28	3/12	18
1992	1993	3/27	3/07	3/25	20
1993	1994	3/29	3/21	3/26	8
1994	1995	4/05	3/17	3/29	19
1995	1996	4/07	2/26	2/28	40
1996	1997	4/07	2/20	3/16	46
1997	1998	3/11	2/23	3/06	16
1998	1999	3/30	3/03	3/15	27
1999	2000	3/27	2/23	3/20	32
2000	2001	3/10	2/26	3/06	12
2001	2002	3/25	3/04	3/18	19
2002	2003	3/08	2/24	3/03	12
2003	2004	3/21	2/23	3/15	26
	Average	**3/24~~6~~**	**3/01~~2~~**	**3/14~~5~~**	**23~~4~~**

Source: Seiler et al., ~~Volkhardt and Fleischer~~ 2005B

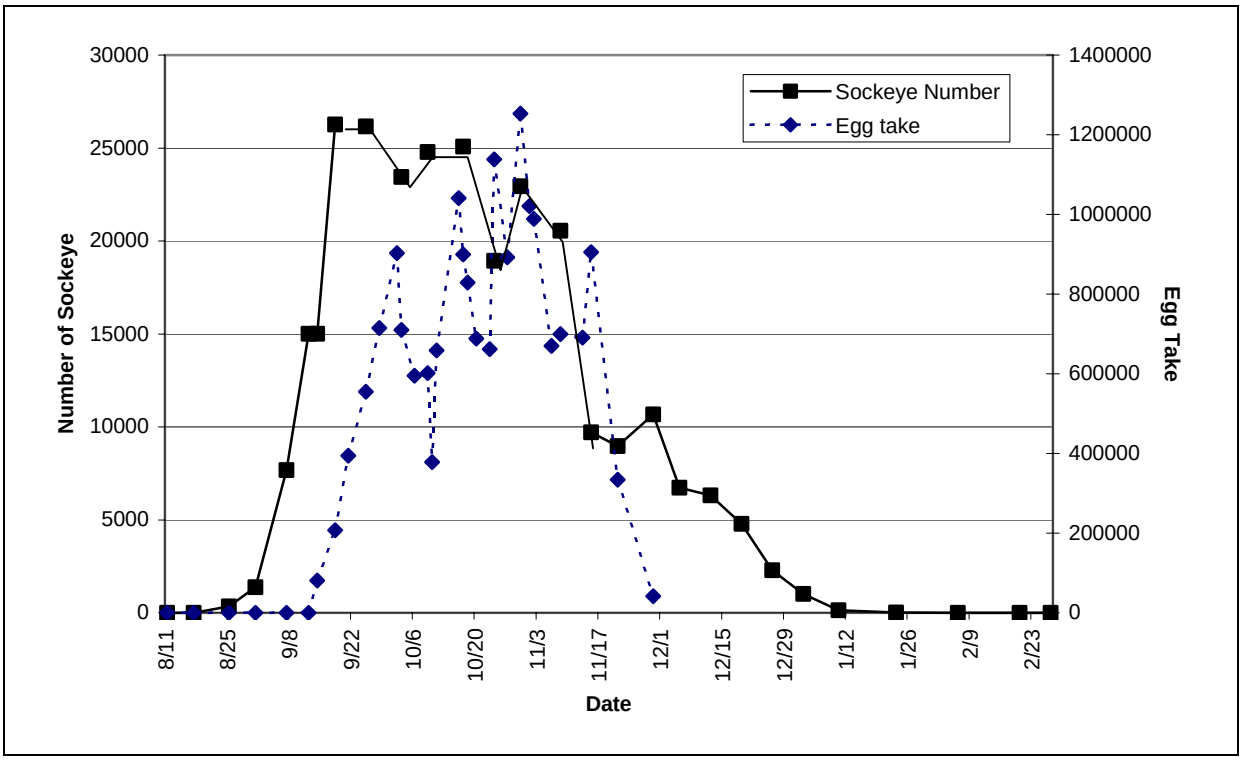


Figure 2-1. 2000 Egg Take Timing at the Hatchery and Counts of Live Sockeye in the Cedar River (WDFW data).

In the past, ~~A~~a portion of the outmigrating fry ~~are~~ were measured at the fry trap. The average fry size is 29 mm (± 1 mm). The size of hatchery and natural fry at this time is assumed to be similar, as hatchery fry are not reared (David Seiler, WDFW, pers. comm.).

The fry trapping data allows estimates of in-river survival of some hatchery fry and the relationship between their survival, their release site along the river, and conditions during migration. Survival of naturally produced fish from the time of egg deposition to the time they reach the migration trap and the relationship between those survival rates and river discharge are estimated based on estimates of escapement and fecundity. In general, in-river survival of hatchery fry increased with river discharge during migration (Seiler and Kishimoto 1997b). For naturally produced fry, survival rates were negatively correlated with river discharge during the incubation period (Seiler and Kishimoto 1997b). Higher river discharges during egg incubation apparently decrease survival by mobilizing riverbed sediments, resulting in bed scour (Ames and Beecher 2001).

Pre-smolt surveys have been conducted each year in March or April. Scientists use these data to estimate the number of sockeye juveniles that are about to leave the system that year, as well as determine their average size. The results of these studies are forthcoming and will be regularly integrated into the AMP process.

Since 1995, studies on salmon smolts have been occurring at the locks. These studies mostly focus on chinook smolts, but also address the travel time, travel speed and

residence time of coho and sockeye salmon and steelhead trout. These studies have not examined sockeye size or other hatchery-related topics (Fred Goetz, U.S. Army Corps of Engineers, pers. comm.).

2.1.3 Remaining Unknowns

What mixture of natural and hatchery production is adequate to maintain ecological integrity of the Cedar River population?

The intent of the hatchery program is to boost production in the system without significantly lowering the ability of the sockeye population to successfully reproduce in the river. Therefore, there is a desire to keep a stable and healthy balance between the number of hatchery and naturally produced sockeye salmon at all life history stages. Based upon hatchery objectives, a population of 100 percent hatchery fry would represent a failure. However, it is not known at what point the population composition is balanced.

Based upon fisheries management policy and early analysis by the science panel (Brannon et al. 2001), the population composition should be about 50 percent hatchery and 50 percent natural returning adults (see the Capacity Analysis for a further discussion). If we assume that survival is roughly equal between the two groups after the incubation stages, then 50 percent would be the target composition at the fry stage. However, there are several unknowns about this composition from an ecological standpoint:

- It is not known how a 50 percent hatchery population would affect the ability of the population as a whole to spawn in the river.
- Given the effects of river scour on the natural population, there will be variability in the system depending on river conditions.

Overall, this important question cannot be easily answered. From the policy standards established, it will be assumed that 50 percent hatchery is the acceptable average for hatchery presence in the population. Adaptive management of other uncertainties (e.g., reproductive success, Lake Washington ecosystem health) will help assess this standard over time.

What are the growth, survival, and population composition of Cedar River sockeye fry once they enter Lake Washington?

There are limited~~no accessible~~ data on the size and growth of hatchery and naturally produced sockeye fry in Lake Washington (Schroder memo, WDFW, 2005). The WDFW has been conducting pre-smolt estimates within the lake since the late 1960s or early 1970s. It is hoped that the results from these studies can be examined to identify trends in the size and growth of sockeye fry at the pre-smolt stage over the last 20+ years to provide a baseline for average size and growth, their variability, and relationship to density. Through establishing a baseline, it will be possible to detect any difference that might be seen in the Cedar River population as hatchery production increases. The otoliths of sockeye salmon produced at the interim hatchery have been marked by exposure to distinct thermal regimes, so those caught in the pre-smolt surveys are identifiable as hatchery or naturally produced. These samples will

provide a basis for examining size differences between hatchery and natural fry at this stage and estimating the population's composition (hatchery and natural).

What are the growth, survival, and population composition of Cedar River sockeye smolts migrating through the locks?

Research on smolt passage at the locks has been conducted since 1995; however, there are no available data on sockeye size, growth, or hatchery-natural composition at this life stage. It is difficult to justify quantification of smolts as hatchery or natural as it would require lethal sampling that would affect other sockeye populations in the basin. In addition, pre-smolt sampling that occurs one to two months prior to smolt migration provides a comparable time point because much of the in-lake growth and mortality has likely taken place by this time. Due to these facts, the AMP focuses on pre-smolt sampling. However, smaller sample sizes will be used to establish ratios of hatchery smolts to wild smolts and their relative sizes.

2.1.4 Hypotheses

The following hypotheses will guide research and monitoring studies for this uncertainty.

- There is no difference in migration timing between hatchery and naturally produced fry.
- At the time of emergence, there is no difference in size of hatchery and naturally produced fry.
- The average proportion of hatchery fry in the Cedar River sockeye population does not significantly exceed 50 percent.
- At the time of pre-smolt surveys, there is no difference in size of hatchery and naturally produced fry.
- At the time of pre-smolt surveys, the proportions of hatchery and naturally produced sockeye do not differ from those that entered the lake as fry.

2.1.5 Monitoring and Research Plan

Migration Timing

Migration timing of sockeye population in the Cedar River should continue to be examined through fry trapping at the mouth of the river. The hatchery is designed to contain equipment to alter the water temperature in the hatchery to more closely follow the temperature of the river. Studies of migration timing should start when the new hatchery begins operation and continue for up to eight years to determine the effectiveness of this activity in matching the migration timing of hatchery and naturally produced fry. The developmental rate of salmon embryos is closely controlled by temperature, and after a few years it may be clear that only careful monitoring of temperature regimes is necessary to project emergence timing.

Fry Size at Emergence

Examination of naturally produced fry trapped at the mouth of the Cedar River can readily determine the size of these fry. Samples will need to be collected throughout emergence at the hatchery to provide comparable data. Fry retained for otolith analysis should have their length and weight recorded so that an average, range and variance for hatchery and naturally produced fry can be calculated. These studies will coincide with those on migration timing, and will depend on the results of all fry trapping studies.

Fry Population Composition

The population composition of Cedar River fry should continue to be monitored. ~~through fry trapping and otolith examination.~~ The composition estimates should cover years of varying escapement and river conditions to provide an accurate idea of the average and variability. These studies will occur over the first eight years of hatchery operations, coinciding with migration timing and fry size studies, and further data collection will be dictated by the results of all fry trapping studies.

Pre-Smolt Size and Growth

Annual pre-smolt surveys should be supported to allow comparisons of size and survival between hatchery and naturally produced fry, identified by otoliths. Comparison between sizes of fry entering the lake the previous spring and size of pre-smolts should allow growth estimation for the two groups.

Comparison of the relative survival and growth of sockeye fry will be complicated by the presence of naturally produced fry from other tributaries in the system (notably but not exclusively Bear Creek). These fish, if not accounted for, would influence the size and growth estimates of naturally produced Cedar River fry. It might be necessary to quantify the size of fry from northern lake tributaries and determine if any differences exist between the Cedar River and other sockeye fry populations. If there are no differences, then it could be assumed that there is not a high amount of bias in the growth and size estimates of naturally produced Cedar River fry due to presence of other wild sockeye populations. Study plans will account for this complication in their design.

In addition, it should be possible to collect scales from adult salmon (e.g., from fishery sampling) and back calculate their size as smolts. By also examining the otoliths, one could compare sizes of hatchery and naturally spawned fish. Scales removed from fully mature salmon can be difficult to read so recoveries at the hatchery and spawning grounds might not be suitable for such analysis.

This study should be conducted annually for up to 10 years and could be combined with studies of lake carrying capacity (see Uncertainty #5).

Pre-Smolt Population Composition

During pre-smolt surveys, fish should be collected to recover otoliths and identify the proportion of hatchery and naturally spawned fish for comparison with the proportions of hatchery and naturally produced fry entering the lake to determine if

there is a difference in survival. As with the assessment of growth, the presence of wild fry from populations besides the Cedar River will complicate this analysis. Some idea of the contribution of sockeye from other tributaries to the lake population should be obtained. Ideally, fry would be trapped from the major tributaries (Issaquah Creek and Bear Creek) but in the absence of such data the abundance of these groups of fry might be estimated from counts of adults in the creeks and estimates of fry production from assumed survival rates or short-term field studies. In years when the basin's population is dominated by the Cedar River this may not cause much error, but large escapements to sites other than the Cedar River will weaken the analysis of fry to pre-smolt survival rates. Study plans will address this complication when developed. This monitoring will occur in the same years as fry population composition to allow for comparison data (initially, years 1 through 8).

Budget

The Habitat Conservation Plan (HCP) budget allocated a total of $662,480 (1996 dollars) for fry trapping and counting and $378,560 for fry marking and evaluation for 50 years. For each year, between 1 and 8, $41,405 was allocated for fry trapping and counting. Fry marking and evaluation is allocated $23,660 per year for years 1 through 8.

Table 2-3 provides a breakdown of the HCP allocation for the category each hypothesis falls into and the estimated amount that each study would cost. It should be noted that the pre-smolt survey cost is estimated at $19,000 and is not a specific HCP commitment. Nevertheless HCP funding and other sources have been identified to continue this monitoring activity due to its importance and efforts will be made to continue to support pre-smolt surveys.

2.1.6 Adaptive Management Actions

Migration Timing

Potential Study Outcomes

For migration timing, the potential study outcomes are as follows:

1. There is no significant difference in the migration timing of hatchery and naturally produced fry.
2. There is a significant difference in the migration timing of hatchery and naturally produced fry.

Threshold

If the timing of wild and hatchery runs differed, the process described in Section 4.8 will be followed to determine the cause and identify steps needed to rectify it. The timing of the migrations would be deemed "different" if statistical analysis of the distributions (e.g., test of means or medians, depending on the normality of the data) indicated a less than 5 percent chance that they were similar in two years out of five.

The unfavorable outcome would be a significant difference in migration timing between the two groups, which could lead to reduced survival of hatchery fish.

Currently there is a difference in migration timing between hatchery and naturally produced fish. To adjust the hatchery timing to more closely resemble the timing of naturally produced fish, the hatchery is to alter water temperatures to mimic the temperatures in the river. Initial study results will determine whether that is an effective method to fix the differential in migration timing. After implementation of water chilling, if a difference in migration timing is still found, other corrective measures would need to be developed.

TABLE 2-3.
ANNUAL BUDGET ALLOCATION FOR HYPOTHESES RELATED TO SIMILARITY IN FRY SIZE, GROWTH, AND MIGRATION TIMING BETWEEN HATCHERY AND NATURALLY PRODUCED FRY, AS WELL AS THE CEDAR RIVER JUVENILE POPULATION COMPOSITION FOR THE FIRST 10 YEARS

		HCP Allocation		AMP		
Hypothesis	HCP Budget Category	Years	Amount[a] (per year)	Years[b]	Estimated Cost (per year)	Comments
Migration Timing	Fry migration timing and size	1-8 24-27 42-45	$41,405	1-8	$40,000[c]	Conduct with size and composition studies
Fry Size	Fry migration timing and size	1-8 24-27 42-45	$41,405	1-8	$40,000[c]	Conduct with timing and composition studies
Fry Population Composition	Fry marking and evaluation	1-8 24-27 42-45	$23,660[d]	1-8	$83,000[e]	Conduct with size and timing studies
Pre-Smolt Size and Growth	None	—	—	Each year	$19,000	Funding from other sources
Pre-Smolt Population Composition	Fry marking and evaluation	1-8 24-27 42-45	$23,660	1-8	$15,000[f]	Funding from other sources

a. Total amount allocated to all activities within that budget category (1996 dollars).
b. Study years within the first ten years of the hatchery only. Further studies will be decided through analysis of study results.
c. The total fry trapping cost is $80,000, which includes both WDFW overhead and trapping for all species of salmon in the Cedar River. The City contributes about $40,000 annually.
d. This covers $23,000 for fry marking in the hatchery.
e. This estimate includes $23,000 for fry marking in the hatchery, plus subsequent otolith analysis assuming 150 otolith samples per night for 30 nights at $13 per otolith.
f. Estimate is for otolith analysis only. Boat time and sample collection are included under the pre-smolt size and growth estimate.

Table 2-4 includes additional factors that could cause earlier migration timing of hatchery fish and ways to change operations to reduce the influence of that factor. At this time, it appears that the egg take timing does not begin before spawning in the river; however, this condition should be further analyzed if water temperature corrections are not effective.

TABLE 2-4.
FACTORS (OTHER THAN WATER TEMPERATURE) THAT COULD CAUSE EARLIER MIGRATION TIMING OF HATCHERY FISH AS COMPARED TO NATURALLY PRODUCED FISH AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Collection of too many hatchery fish at the beginning of the spawning season.	Further study of egg take timing and river spawning timing. If a contributing influence of egg take timing is found on differential migration timing, the egg take/broodstock collection schedule should be altered to reduce the number of eggs/fish taken at the beginning of the run and increase the number of eggs/fish taken later in the run.
High density of alevins in the incubator promoting more rapid development	Alevin density can affect development rates. However, this relationship is also influenced by flow and substrate depth (Derek Poon, U.S. E. P. A., pers. comm.). Incubator conditions should be altered if this is a factor in earlier migration timing (e.g., reduced density, changes in water flow rates).

Fry Size Before Entering Lake Washington

Potential Study Outcomes

The potential study outcomes for this hypothesis are:

1. There is no difference in size of emergent hatchery and naturally produced fry from the Cedar River.
2. There is a difference in fry size of emergent hatchery and naturally produced fry from the Cedar River.

Threshold

If the lengths of natural origin and hatchery fry differed, the process described in Section 4.8 will be followed to determine the cause and identify steps needed to rectify it. The size of the fry would be deemed "different" if statistical analysis of the distributions (e.g., test of means or medians, depending on the normality of the data) indicated a less than 5 percent chance that they were similar in two years out of five.

The unfavorable outcome for this study would be a difference in fry size between the two groups. Abnormally small fry from the hatchery would have a handicap, resulting in low post-release survival rates. Large hatchery fry would have competitive advantages that would increase survival, complicating integration of natural origin and naturally produced fish. Size differences as small as 2 to 3 mm can greatly affect swimming performance and predator avoidance (Bams 1967), which ultimately affect fry survival. The difference in survival would alter the balance in the composite

population. Different factors influencing fry size are listed in Table 2-5 with their potential methods of correction.

TABLE 2-5.
FACTORS THAT COULD CAUSE A DIFFERENCE IN THE SIZE OF HATCHERY AND NATURALLY PRODUCED FRY AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Direct or indirect selection of females for the hatchery with respect to body size, causing selection for egg size.	Ensure that broodstock collection methods result in random selection of females.
Hatchery rearing	Do not rear fry. Release them as soon as possible after volitional emergence.
Incubation substrate	Provide sufficient incubation substrates to avoid excessive alevin activity.

Pre-Smolt Size and Growth

Potential Study Outcomes

Potential outcomes for this research hypothesis are:

1. The size and growth of hatchery and naturally produced pre-smolts in Lake Washington are similar to each other.
2. The size and growth of hatchery and naturally produced pre-smolts in Lake Washington are significantly different from each other.

Threshold

If the lengths, weights, or condition factors (weight-length relationships) of natural origin and hatchery pre-smolts differed, the process described in Section 4.8 will be followed to determine the cause and identify steps needed to rectify it. The size of the pre-smolts, based on spring sampling, would be deemed "different" if statistical analysis of the distributions (e.g., test of means or medians, depending on the normality of the data) indicated a less than 5 percent chance that they were similar in two years out of five.

The undesirable outcome would be a difference in size and growth between the two groups. The potential causes of growth differential are listed in Table 2-6 along with potential methods of correction.

TABLE 2-6.
FACTORS THAT COULD CAUSE DIFFERENTIAL GROWTH BETWEEN HATCHERY AND NATURALLY PRODUCED PRE-SMOLTS AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Physiological condition causing an advantage or disadvantage in foraging and avoiding predators	Examine and alter size or attributes of fry leaving the hatchery/adjust release strategy.

Timing of release from the hatchery	Adjust the timing of hatchery fry to better match that of the naturally produced fish (see Table 2-4).

Pre-Smolt Population Composition

Potential outcomes of this hypothesis study include:

1. There is no difference between fry and pre-smolt population composition.
2. Hatchery pre-smolts represent significantly less than or greater than their proportion in the fry population, after accounting for fry produced outside the Cedar River.

The undesirable outcome would be more than 50 percent hatchery pre-smolts in the lake sockeye population (after accounting for other Lake Washington sockeye populations), or a decline in hatchery contribution to the overall population. Table 2-7 lists potential causes for a change in the proportion of hatchery pre-smolts in the Cedar River population and potential remedies.

TABLE 2-7.
FACTORS THAT COULD ALLOW A CHANGE IN THE REPRESENTATION OF HATCHERY FISH IN THE PRE-SMOLT POPULATION AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Higher survival of hatchery fry while in the lake due to size or release date.	See correction methods under fry and pre-smolt size, growth and timing (see Tables 2-5 and 2-6).
Selective pressures favoring survival of hatchery pre-smolts over natural pre-smolts.	This would be difficult to measure and would likely have to be conducted with studies of the lake ecosystem if thought to be a significant factor.
Under-representation of hatchery fry caused by disease or behavior impairment.	Increase scrutiny of fry leaving the hatchery for health and minimize practices that could induce maladapted behavior.

2.2 UNCERTAINTY NO. 2—DOES THE HATCHERY REDUCE THE REPRODUCTIVE SUCCESS OF CEDAR RIVER SOCKEYE SALMON?

2.2.1 Definition and Importance

Reproductive success is the number of progeny produced per adult that survive to reproduce themselves. There are several components of reproductive success, including the number and size of eggs produced by females, their competence in selecting, preparing and defending breeding sites, and the survival of their offspring after emergence. For males, reproductive success depends on the ability to gain access to ripe females and fertilize eggs, and the survival of those embryos. Reproductive success is a complex function of individual traits (chiefly related to body size and date of spawning), density-dependent processes (including competition for breeding space by adults, competition for food by offspring, and predation), and environmental factors

such as flooding in the river where spawning and incubation occur and temperature in the lake and at sea. Reproductive success is therefore a result of intrinsic, genetically influenced individual traits as well as processes extrinsic to the individual fish.

The life history patterns (e.g., size and age at maturity, egg size, spawning date, etc.) of populations are evolutionary adaptations to maximize reproductive success. The Cedar River population is not native, and the low reproductive success of the population (that is, few returning adults per spawner) may in part reflect the mismatch between genotype and environment. Reduction in reproductive success of the naturally spawning population would reduce the overall productivity of the system and might accelerate the decline of the naturally spawning population. Operation of the hatchery could affect reproductive success through various processes.

First, the hatchery might reduce the reproductive success of the naturally spawning population by removing some selective pressures on reproductive traits such as courtship and redd site choice. By spawning fish at random in the hatchery, smaller or weaker fish that would be at a disadvantage in the river might produce as many offspring as stronger individuals. Through time this can alter the reproductive success of the population.

Second, there might be some alteration in the genetic composition of the hatchery population ("domestication selection") rendering them more fit for the hatchery and less fit for natural conditions. Such inadvertent selection has been documented, and at least some of the poor performance of hatchery-origin steelhead spawning in rivers compared to sympatric wild steelhead may result from this process (Chilcote et al. 1986; Leider et al. 1990), although steelhead hatcheries rear their fry for a year or more while the sockeye hatchery would be releasing the fry soon after they leave the incubators.

Third, the hatchery may tend to select for phenotypes that are natural but that do not represent the full spectrum of the naturally spawning population. The adults have an unusually protracted period of spawning (from September until December or even later) compared to other sockeye salmon populations. It is not clear whether this reflects recent evolutionary adaptation to the Cedar River and Lake Washington basin or ancestral patterns. Baker Lake sockeye, from which the Cedar River population is thought to be largely derived, do spawn over a similar time period (late September to December; Washington Department of Fisheries et al. 1992). There is a strong genetic basis for spawning timing in salmon, and other life history traits tend to co-vary with spawning date such as body size, energy and reproductive allocation (Hendry et al. 1999), and the location of spawning. Assuming the present condition reflects natural selection in the Lake Washington basin, a change in the temporal and spatial distribution of spawning might reduce the reproductive success of naturally spawning salmon in the future.

2.2.2 Existing Data and Knowledge

Some data on the age, size, egg size, fecundity, and morphology of Lake Washington (including Cedar River) sockeye were reported by Quinn et al. (1995) and Hendry and Quinn (1997). WDFW has been conducting research on sockeye returning to the Cedar

River. Their data includes an examination of size, fecundity, egg size, and age at maturity of hatchery and naturally produced fish. These data are currently being analyzed and will be considered in the adaptive management process as they are available.

Results of otolith analysis of sockeye collected between 1997-2000 are presented in Fresh et al. (2003). They conclude that in some comparisons hatchery origin female sockeye were significantly smaller than those of natural origin females of the same age. They also conclude that there are differences in adult distribution during spawning and that the broodstock collected to date are timed earlier than the overall run. They found no significant differences in age at maturity or return timing between hatchery and natural origin returns.

In addition to research on phenotypic traits, there have been several studies of the genetic structure and ancestry of Lake Washington basin sockeye (e.g., Hendry et al. 1996, 2000; Bentzen and Spies 2000; Spies et al. 2001; Young et al. 2001). Despite this work, there is considerable uncertainty about the origins and present structure of the populations. It seems most likely that the present Cedar River population was derived from transplants from the Baker Lake system in the 1930s and 1940s, though it is difficult to rule out contributions from other transplants. Moreover, the existence of small native sockeye and kokanee populations in the Lake Washington system (though probably not the Cedar River) seems likely but it is difficult to be certain which (if any) present populations represent pure "native" sockeye.

2.2.3 Remaining Unknowns

Is there a trend in body size, fecundity and egg size through time?

Many Pacific salmon populations, including ones in the Puget Sound area, have experienced declines in body size over the past decades; in others there is evidence of significant annual variation. There are many possible reasons for this, including but not limited to, changes in smolt size (including hatchery effects), changes in age composition of spawners, temperature regimes and competition for food at sea, and selective fishing. Declines in size may manifest themselves in reduced fecundity (Washington and Koziol 1993). It is possible that changes in growing conditions in the lake (i.e., smolt size) could affect age composition and fecundity, however, this relationship has not been examined in Lake Washington. It is possible that data from ongoing studies or retrospective analysis of existing data could shed light on this question.

What is the relationship between spawning date and location of spawning?

Sockeye salmon that return early to the Cedar River tend to spawn in the upper reaches of the river to a greater extent than those returning later (Ames and Beecher 2001). ~~Recent r~~Recoveries of otoliths from experimental groups released from the hatchery into the upper, middle and lower reaches of the river indicated that adults tend to return to the site where they were released more often than would occur by chance (~~Kurt~~ Fresh et al, 2003~~WDFW, pers. comm.~~). During the period of evaluation, samples taken during the broodstock collection period, suggest that hatchery returns tended to favor upstream spawning areas more so than naturally produced sockeye.

Therefore, it is likely that naturally spawned fry emerging from specific reaches of the river will return to those reaches, resulting in partial segregation of the run in space and time. There is abundant evidence that early and late spawning salmon differ in longevity and other life history traits (Perrin and Irvine 1990; Hendry et al. 1999), and so timing is not merely a random variable but is associated with other important adaptations. Therefore, it is important to understand how adults returning over the course of the spawning season distribute themselves in the river.

2.2.4 Hypotheses

Abundance, life history patterns, and genetic structure of salmon populations are not fixed. Some variation is both inevitable and beneficial. Nevertheless, some changes would foreshadow declines in fitness and are cause for concern. The following null hypotheses will guide initial monitoring and research studies for this uncertainty.

- The size and age composition of the population at maturity of Cedar River sockeye will not show a trend over time.
- The relationships between body size, fecundity and egg size of female sockeye in the Cedar River will remain constant.
- The spatial and temporal distribution of spawning will remain constant over time.
- There will be no difference in reproductive success between hatchery and naturally produced sockeye spawning naturally.
- There will be no trend toward lower overall reproductive success of naturally spawning sockeye over time.
- The genetic composition of the Cedar River sockeye population will not change over time.

2.2.5 Monitoring and Research Plan

Size and Age at Maturity

To investigate size at age, adult sockeye should be sampled for otoliths or scales to determine age and their length should be measured. This will allow a long-term comparison of size at maturity to determine if sockeye are becoming smaller or if the age composition is changing. As part of routine operations, a sample of the adult salmon spawned at the hatchery and carcasses retrieved from the river need to be measured and their otoliths removed to assess the proportion of hatchery and naturally produced fish. Body size measurements should use the same methods each year (e.g., mid-eye to hypural plate) and ages of naturally spawned fish should be validated using otoliths of known-age hatchery fish. Size data should be collected at the hatchery annually from fish spawned on each egg-take date. Otolith collection, at both the hatchery and in the river, should occur in years 1-10. Lengths of fish spawning in the river should also be collected during years 1-10. Further data collection will depend on initial study results and analysis.

A broodstock collection site located as close as possible to the mouth of the Cedar River would allow collection of a random sample of sockeye as they migrate. (The

location of the broodstock collection facility used for the interim hatchery limits access to later returns and to downriver spawners.) A sampling approach could then be developed to gather samples that accurately characterize the sockeye run.

Fecundity and Egg Size

Female body size, egg size, and fecundity should be examined over time to determine if any decrease is occurring in the population. Study methods should include taking female lengths, weighing the total mass of fresh (i.e., not water-hardened) eggs she produces, and collecting a small number (about 50) for separate weighing and counting. This should provide an accurate estimate of egg size, fecundity, and gonadosomatic index. These females should also be sampled for otoliths to determine age and origin (hatchery or river). This should allow detection of any differences in reproductive output between natural and hatchery fish, and among hatchery treatment groups. Relationships between size, age, egg size, and fecundity can also be examined.

Spawning Date and Location

To examine how spawners returning at different times over the spawning run distribute themselves in the river, tagging studies should be conducted. Adult sockeye should be trapped at the mouth of the river or the broodstock collection facility at various times during the spawning run and tagged. Recovery surveys should then be conducted to trace where those fish go in the system and ultimately spawn. These studies could be conducted in connection with tagging and movement studies of sockeye in the lake as well (see Uncertainty No. 3), and should be connected with length, age, and otolith examination.

Reproductive Success

The null hypothesis is that after one or more generations of breeding in the hatchery, the reproductive success of naturally spawning sockeye salmon will not differ between individuals whose parents were bred in the hatchery and those whose parents were not. Under this hypothesis, hatchery-bred fish spawning in the river (from the first years of the hatchery) would produce progeny that could not be distinguished from naturally spawning fish, so only the effects of a single generation of hatchery production could be assessed.

This hypothesis could be tested by allowing adults (of unknown parentage) to enter and spawn in a discrete area such as a spawning channel. Otolith examination (post-mortem) would determine their origin and DNA parentage analysis (from fin-clips of adults and fry) could determine whether the *per capita* fry production differed between naturally spawning and hatchery parents. This assessment would depend on having a mix of naturally spawning and hatchery parents; if all the parents were hatchery produced then no light would be shed on the question. This would not be known until after the spawning had taken place, and so the study should be conducted in a season when an approximately equal ratio is expected. This study should be conducted in years 1-2 and repeated in years 9-10.

In addition to this direct (albeit somewhat controlled) comparison, the reproductive success of the two groups could be compared in an indirect, less controlled manner. Knowing the number of females that spawn in the river each year and estimating (from otolith examination) the proportion of hatchery females, will allow comparison of the number of fry produced per female among years with varying proportions of hatchery females. The drawbacks to this method are that many years of data would be required and that other factors affecting fry production (notably density, flow, and variation in spawner distribution) would have to be considered in the analysis.

The possibility of the population becoming progressively less fit for natural reproduction will have to be evaluated. This is complicated by non-genetic factors (notably flooding during incubation and flow-related survival during migration by fry to the lake). However, a decrease in the flow-adjusted survival rate over time would be cause for concern because even under present conditions the naturally spawning populations is barely replacing itself. To evaluate this possibility, adult to adult survival for hatchery and natural origin groups within year and over time will be evaluated along with fry production per capita for naturally spawning sockeye.

Genetic Composition

Life history traits such as spawning date and body size reflect both genetic and environmental influences. In addition to these phenotypic traits that are subject to natural selection and affect fitness, there are biochemical and molecular traits that appear neutral to selection and are not influenced by environmental conditions. Such traits have been used to test hypotheses regarding ancestral origins and present population structure in the basin (Hendry et al. 1996, 2000; Bentzen and Spies 2000; Young et al. 2001). Because the different variants of the alleles apparently confer no fitness benefits, there is no "ideal" genetic composition that needs to be maintained. Rather, it is generally believed that levels of genetic diversity, as indicated by these traits, are associated with the overall health of the population (Ryman 1991; Waples 1991). In addition, shifts in gene frequency might be associated with changes in adaptive traits not being measured.

Over the past few decades there have been many very rapid changes in the tools used for studying the genetic composition of populations, and we might anticipate further advances in this scientific discipline (Carvalho et al. 1994). Progress has been made, not by rejecting early techniques (e.g., polymorphic proteins) but by adding other techniques and markers (e.g., mitochondrial and nuclear DNA). It therefore would be unwise to recommend any particular technique for genetic analysis. Rather, it will be most important to collect and archive samples from a fraction of the naturally and hatchery produced salmon, and from other spawning populations in the basin, such as Bear Creek. Annual processing of these samples will be unnecessary and no specific management action would result from small changes in the frequency of alleles in the population. However, it would be prudent to conduct analysis on a periodic basis to track trends over time. Genetic studies should occur at the end of the first decade of hatchery operations (years 9-10), in conjunction with reproductive fitness studies.

Budget

The HCP budget allocated a total of $567,840 over the life of the project to monitor phenotypic and genetic traits, tentatively budgeted as $35,490 per year for years 1-4, 9-12, 28-31, and 46-49. Otolith recovery from returning adults was budgeted at $47,320 per year for years 1-12, 28-31, and 46-49. These years were presumably selected to permit collection of the returning adults that had been marked in the earlier years (24-27 and 42-45) and to parallel genetic analyses. Table 2-8 presents the allocated and estimated budgets.

2.2.6 Adaptive Management Actions

Size and Age at Maturity

Potential Study Outcomes

Plausible outcomes of this study are as follows:

1. There is no trend in size and age at maturity of Cedar River sockeye over time.
2. There is a trend toward decreasing size at age and increasing age at maturity, or increasing size at age and decreasing age at maturity of Cedar River sockeye over time.

Threshold

If the size at age or age composition of natural origin and hatchery produced adults differed, the process described in Section 4.8 will be followed to determine the cause and identify steps needed to rectify it. The size of the adults, based on random samples from the weir, would be deemed "different" if statistical analysis of the distributions indicated a less than 5 percent chance that they were similar in two years out of five.

TABLE 2-8.
BUDGET ALLOCATION FOR HYPOTHESES RELATED TO REPRODUCTIVE FITNESS AND GENETIC COMPOSITION OF CEDAR RIVER SOCKEYE FOR THE FIRST 10 YEARS

		HCP Allocation		AMP		
Hypothesis	HCP Budget Category	Years	Amount[a] (per year)	Years[b]	Estimated Cost (per year)	Comments
Size and age at maturity	Otolith recovery from returning adults	1-12 28-31 46-49	$47,320	Size: annual Otoliths : 1-10	$45,000[c]	Conduct in conjunction with fecundity and egg size sampling
Fecundity and egg size	Phenotypic and genetic traits	1-4 9-12 28-31 46-49	$35,490	Annual	Hatchery Operation	Should be a routine hatchery operation
Spawning date and location	None	—	—	1-4	$25,000	Conduct in conjunction with otolith recovery
Reproductive Success	None	—	—	1-2 9-10	$35,000	Combine with genetic composition in all but years 1-4

a. Total amount allocated to all activities within that budget category.
b. Study years within the first ten years of the hatchery only. Further studies will be decided through analysis of study results.
c. Size measurements at the hatchery should be integrated with hatchery operations. Measurements of salmon from the river and otolith extraction and processing are accounted for in the cost estimate. This supplies only a portion of the total amount. A total budget of $167,000 would be required for collection of otoliths in the field and at the hatchery, otolith analysis, fry marking, data analysis and report preparation, and WDFW overhead (Kurt Fresh, WDFW, pers. comm.). $23,000 for fry marking is included in the budget for Uncertainty #1 (see Table 2-3).

Length at age data would be examined by analysis of variance with age and brood year as factors. Age composition would be tested by a chi-square contingency test or other test for categorical data. In addition, their might be a progressive trend that was not significant in a few years but was evident over time. To test for such a trend, the average length at age 1.2 (the modal age for this population) would be calculated for natural origin and hatchery adults. We would first test for a significant trend in each population, and then if the slopes differed significantly from 0 (i.e., there was evidence of a trend) we would compare the slopes from the two groups. These regression relationships would be calculated annually.

The undesirable outcome would be significant differences in age at maturity or size at age between hatchery and natural origin adult returns. Table 2-9 lists the potential causes of this outcome and possible methods of correction.

TABLE 2-9.
FACTORS THAT COULD CONTRIBUTE TO DIFFERENTIAL SIZE AND AGE AT MATURITY FOR CEDAR RIVER SOCKEYE AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Alteration of size-selective pressures in the hatchery.	Through AMP, review hatchery procedures and adjust as appropriate.
Smaller smolts spending more time in the ocean.	Assess smolt size and reduce the production of fry if the changes are serious enough to compromise the population's productivity. Adjust release strategy.
Changes in growing conditions at sea.	Nothing, but need to incorporate these changes into forecasts for capacity and egg needs.

Fecundity and Egg Size

Potential Study Outcomes

Plausible outcomes of this study include:

1. Egg size and fecundity of returning female Cedar River sockeye remain unchanged over time, as absolute averages and as functions of body size.
2. There is a reduction or increase in egg size and fecundity relative to body size of returning female sockeye salmon in the Cedar River over time.

Threshold

Egg size and fecundity will be examined by ANOVA with origin (natural or hatchery) and brood year as factors. Such analysis does not consider differences in body size, however. Accordingly, the data will also be examined using ANCOVA (analysis of covariance) with length as the covariate to determine if the natural and hatchery produced fish differ in reproductive output as a function of body length. To test for trends over time we will use both the raw mean egg size and fecundity data and size-adjusted data by using the expected value for each year at a fixed length. That is, we will calculate the slope of the length-fecundity relationship for each year and then estimate the fecundity of females of a given length (e.g., 60 cm) in each year. If any significant patterns are detected, the process described in Section 4.8 will be followed to determine the cause and identify steps needed to rectify it.

The undesirable outcome would be a reduction in egg size or fecundity in females. Table 2-10 lists the potential causes of these reductions and possible methods of correction.

TABLE 2-10.
FACTORS THAT COULD CONTRIBUTE TO REDUCED EGG SIZE AND FECUNDITY IN CEDAR RIVER SOCKEYE FEMALES AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Smaller female body size results in fewer or smaller eggs.	Determine whether the decline is related to growth rate or age at maturity, and examine ecological processes and possible inadvertent selection in the hatchery. Ensure broodstock is representative at the run.
Slower growth in fresh water could result in fewer, larger eggs relative to body size. (Might not be true for sockeye.)	Consider reducing fry production if the changes are serious enough to compromise the population's productivity.
Slower growth at sea results in fewer, larger eggs relative to body size, or more rapid growth results in more, smaller eggs.	Nothing, but need to incorporate these changes into forecasts for capacity and egg needs.

Spawning Date and Location

This subject examines the pattern of spatial and temporal distribution and the co-variation of these traits with life history patterns and with hatchery/natural origin. The first need for this study is to determine the prevailing patterns, building on detailed work done in 1969 (reported by Ames and Beecher 2001). The second need is to determine whether the hatchery might be affecting these patterns.

Potential Study Outcomes

Plausible outcomes of this study include:

1. The spatial and temporal distributions of spawning by sockeye in the Cedar River are independent.
2. There is a tendency for earlier (or later) returning salmon to spawn predominately in the upper (or lower) section of the river.
3. The timing and spatial distribution of salmon is independent of their life history traits (e.g., size, age, in-stream life)
4. Large body size and longer in-stream life are associated with early arrival or upstream distribution.
5. The hatchery-origin salmon tend to return earlier than naturally spawned salmon.

Threshold

The weighted average spatial distribution (corrected for missing values) as indicated by WDFW live counts of sockeye in the Cedar River will not show a significant change

over the years, nor will there be changing interactions between date and location of spawning. Changes from year to year might result from a variety of physical factors, density, etc. and might not indicate an underlying shift in the behavior of the salmon. Accordingly, only progressive shifts of the same nature (e.g., fewer fish spawning at upriver locations) will be considered important, not merely differences in distribution from one year to the next. Such changes will be assessed by separating the river into discrete reaches and binning the counts into these reaches for the temporally discrete surveys each year. If any significant patterns are detected, the process described in Section 4.8 will be followed to determine the cause and identify steps needed to rectify it if the change is related to hatchery practices.

The undesirable outcome would be a tendency for the hatchery broodstock collection to disrupt the natural pattern of spatial and temporal distribution, and co-variation of spawning date with life history traits (notably size and in-stream life). Table 2-11 lists the potential causes of changes in the population and possible methods of correction.

TABLE 2-11.
FACTORS THAT COULD CONTRIBUTE TO DIFFERENTIAL SPAWNING TIMING AND LOCATIONS FOR CEDAR RIVER SOCKEYE AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Broodstock collection practices disproportionately remove a portion of the population in space and time.	Alter broodstock collection schedules to more accurately represent the entire run and encourage full utilization of the river.
Harvest in Lake Washington removes a specific portion of the population.	Determine patterns of lake entry, movements, upriver migration and spawning date and location (see Uncertainty No. 3). Shift broodstock collection practices to spread harvest over the entire run.
Predominant releases of hatchery fry in the lower river.	Sacrifice survival rate to provide full use of the upper river by releasing fry upriver.
Disruption of space-time continuum.	Make sure that fry from early spawning are predominantly released in the upper river and later fry released downriver, if this is the natural pattern.

Reproductive Success

Potential Study Outcomes

Potential outcomes of this hypothesis study include:

1. Hatchery and naturally produced sockeye have similar rates of reproductive success when spawning naturally, and there is no overall trend in fitness over time.
2. Hatchery sockeye have lower rates of reproductive success when spawning naturally than do naturally produced sockeye, and there is a decreasing trend in productivity over time.

Threshold

Estimates of the number of natural origin sockeye salmon fry leaving the Cedar River each year will not show either a significant downward trend over the years, nor a significant correlation with the proportion of hatchery origin spawners in the parental generation. The production of fry is related to both the number of spawning adults and also the peak river discharge during the incubation period. Therefore, the multivariate relationship between fry production and these variables will be calculated, and the residuals from this relationships will be examined from either a time trend or a correlation with the relative abundance of hatchery origin parents. Alternatively, analysis may have to be limited to years with relatively low peak flows (< 100 m3/sec) because when flows are high the survival rates of embryos are so low that there would be little power to detect patterns related to origin or year. If any significant patterns are detected, the process described in Section 4.8 will be followed to determine the cause and identify steps needed to rectify it if the change is related to hatchery practices.

Comparison of adult to adult return rates for hatchery and natural origin sockeye will be made. The adult to adult return for hatchery origin sockeye is expected to exceed that of natural origin sockeye due to the survival benefit of the protected hatchery environment during incubation. The magnitude of this difference will be evaluated each year and over time. Multivariate trend analyses would determine if within year differences in survival rates would be of the same magnitude over time.

The undesirable outcome would be differential reproductive success between hatchery and naturally produced sockeye or a decreasing trend in fitness in the population over time. Table 2-12 lists the potential causes of the reduced fitness in the population and possible methods of correction.

TABLE 2-12.
FACTORS THAT COULD CONTRIBUTE TO DIFFERENTIAL REPRODUCTIVE SUCCESS FOR CEDAR RIVER SOCKEYE AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Relaxation or alteration of sexual selection processes	Alter spawning methods at the hatchery to more closely follow natural conditions. However, this alteration in hatchery methods would not be easy as sexual selection processes are not well understood in natural systems.
Inadequate contribution of naturally produced sockeye salmon to the population.	Increase the target goal of naturally produced adults above 50 percent.

Genetic Composition

Potential Study Outcomes

Potential outcomes of this hypothesis study include:

1. There is no change in the genetic composition of Cedar River sockeye salmon over time, as measured by molecular markers.
2. There is a reduction in genetic diversity in Cedar River sockeye salmon over time.

Threshold

The possible loss in genetic diversity will be assessed using three indicators: 1) the average number of alleles per locus (or the total number of alleles across a standard set of loci), 2) the level of heterozygosity in the population, and 3) the effective population size (Ne), measured on an absolute basis or relative to the total population (i.e., ratio of Ne/N). Significant changes at any of these three indicators would result in initiation of the process described in Section 4.8 to ascertain what might be causing the changes and what steps might be taken to reverse them.

The undesirable outcome would be a reduction in genetic diversity or a dramatic change in genetic composition caused by hatchery practices. Some change, however, is not necessarily undesirable as evolution is a natural process as the population fluctuates randomly and in response to environmental changes. Table 2-13 lists the potential causes of genetic change in the population and possible methods of correction. Note, however, that it is unclear what level of change constitutes a problem. Genetic changes might be difficult to adjust because their correlation with adaptive traits is unknown.

TABLE 2-13.
FACTORS THAT COULD CONTRIBUTE TO A CHANGE IN GENETIC COMPOSITION FOR CEDAR RIVER SOCKEYE AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Relaxation of selective pressures during spawning and incubation.	This is inherent in hatchery practices and probably cannot be corrected.
Selection of unrepresentative salmon for spawning.	Increase efforts to randomly select broodstock to ensure that the tails of the distribution of traits, including timing, size, shape are represented.
Inappropriate breeding scheme.	Consider a different breeding scheme, based on models of genetic drift.

2.3 UNCERTAINTY NO. 3—WILL THE HATCHERY ADVERSELY AFFECT SOCKEYE POPULATIONS OUTSIDE THE CEDAR RIVER?

2.3.1 Definition and Importance

The Cedar River and hatchery are part of the Lake Washington basin that includes other populations of sockeye salmon and kokanee, the non-anadromous form of the species. Kokanee populations spawn in Bear Creek, Issaquah Creek and other creeks. Sockeye also spawn in the Bear and Issaquah Creek systems, as well as other creeks and on beaches of Lake Washington. These populations are important components of

the basin's biodiversity and the overall production of sockeye salmon. They probably include ancestral lineages of *O. nerka* in the basin that pre-date the transplants in the 1930s and 1940s. The sustainability of these putative populations is desirable from the standpoints of both production and conservation. There are several mechanisms through which the sockeye and kokanee populations in the basin could be affected by the hatchery: increased fishing pressure, ecological effects, or genetic effects.

The most direct mechanism by which the hatchery might affect other sockeye salmon populations is by increased fishing pressure, which could reduce other populations below replacement levels. This concern is common to all populations in the basin but is most acute for the beach-spawning sockeye salmon. They are relatively scarce and predominantly spawn in the southeastern section of the lake, so fisheries might be expected to exploit them more than populations migrating to the Sammamish River or Lake Sammamish. If the hatchery increases the number of Cedar River sockeye salmon in excess of the production needs of the hatchery and the river's escapement goal, there will be fisheries to catch the surplus. The more successful the overall production of sockeye from the Cedar River and from the hatchery, the more frequent or heavy the fisheries in Lake Washington will be. Natural populations are expected to be less productive than the hatchery-supplemented population (this is, after all, the point of the hatchery) and could be over-fished, causing their decline or extinction. This can be averted only if the fisheries are managed, in space or time, to catch primarily Cedar River fish. Present fishery management restricts the time, quantity, and location of tribal and recreational fisheries. Each year, the Muckleshoot Tribe and the WDFW evaluate counts of sockeye salmon at the locks from early June to late July. These counts help determine whether a sufficient number of fish have returned to the system to support fisheries without compromising the escapement goal. If the counts are sufficient, the fishery is typically open in July for a matter of weeks, until the surplus fish are caught. Cedar River sockeye are targeted during fishing openings and, to avoid catch of northern lake tributary sockeye, fishing activities are restricted to the region of the lake south of the Evergreen Point Bridge (Highway 520), under the assumption that sockeye migrating to the north end of the lake will predominantly occupy the area north of the bridge. However, the beach spawning populations in the lake may mix with Cedar River fish, making it difficult to manage separately due to mixing and their small population.

The second mechanism by which the hatchery might affect the other sockeye salmon populations is through changes in the lake's ecosystem. This uncertainty is addressed in detail below (Uncertainty No. 5).

Third, it is possible that the hatchery might affect the genetic composition (hence the fitness) of other populations. This might occur if significant numbers of Cedar River sockeye strayed and interbred with the other populations.

2.3.2 Existing Data and Knowledge

There has been some research conducted on the genetic structure of various Lake Washington sockeye and kokanee populations. The extent to which these populations are discrete, and which (if any) represent an ancestral lineage has been a subject of considerable research (Hendry et al. 1996; Hendry et al. 2000; Spies et al. 2001;

Young et al. 2001) with no absolutely certain conclusions. It is not clear whether further genetic research will resolve the uncertainties surrounding the population structure and ancestry of this species in the basin.

A study of sockeye straying rates from the Cedar River hatchery population into Bear Creek was conducted in 1998, 1999 and 2000 with otolith examination. The level of straying into Bear Creek was negligible since no Cedar River hatchery sockeye were found. While some level of straying might have been detected if the sample size of the study had been increased, the study concluded that hatchery strays, if any, would represent significantly less than 0.5 percent of the Bear Creek adults (Fresh et al. 2001). Straying to other creeks, such as Issaquah Creek, would probably be even less frequent, as they are farther from the Cedar River than Bear Creek. Some level of straying is a natural process in salmon and is not necessarily reason for concern. This issue can be regarded as minor unless hatchery practices are changed markedly from those relevant to the study by Fresh et al. (2001). For example, releases of fry in the lake rather than the river might elevate straying rates.

2.3.3 Remaining Unknowns

A two-year study was initiated in 2003 to learn more about the spatial distribution of sockeye salmon in the lake prior to their ascent into spawning streams, the distribution of specific populations in the lake prior to spawning, and the relationship between date of entry into the lake, population of origin, and spawning date. It also is unknown whether the depth distribution of salmon (hence vulnerability to some fisheries) is similar for all populations and how it changes over the summer. Results from the study are expected to be available in 2006.

What is the distribution in the lake of adults from different spawning populations?

By knowing where spawners headed for the Cedar River and the northern tributaries are located within the lake, as well as the extent of their range over the summer, it would be possible to determine the adequacy of the current harvest management regulations. In addition, if the spatial and temporal location of Cedar River sockeye adults were known, fishing could be further managed to minimize catch of other sockeye populations.

What is the population composition of the sockeye harvest in Lake Washington?

It is unknown whether the fisheries (tribal and recreational) catch similar proportions of the different populations of sockeye in Lake Washington, and what the overall patterns of catch by population are. While the aim is to catch only Cedar River sockeye, other populations, such as beach spawners, are probably caught as well. If we understood the patterns of catch, it would be possible to estimate whether harvest of non-Cedar River sockeye occurs at levels that jeopardize their sustainability. If harvest of other sockeye is a problem, it will be important to identify locations and ranges within the lake for these populations and manage fishing accordingly.

What is the relationship between the date of entry into the lake and spawning location?

By knowing the relationship between entry into the lake, timing of spawning, and spawning location, certain time blocks could be set aside as fishing/no-fishing times to maximize harvest of Cedar River fish, minimize catch of other sockeye populations, and protect against compression of the phenotypes and distribution patterns of salmon.

2.3.4 Hypotheses

The following null hypotheses will guide initial monitoring and research for this uncertainty.

- Sockeye harvest in Lake Washington does not capture sockeye from populations outside the Cedar River at levels greater than their productive capacity.
- There is no significant straying by Cedar River hatchery sockeye into other populations.

2.3.5 Monitoring and Research Plan

Harvest

The spatial and temporal distributions of different populations of sockeye in Lake Washington are being examined through a combination of telemetry and conventional tagging. Representative samples of adults entering the system through the locks were tagged and a fraction of them fitted with ultrasonic transmitters and their movements followed in the lake. The combination of tagging techniques should indicate the extent to which sockeye move throughout the lake and the relationship between migration timing into the lake and spawning timing and location. Sockeye salmon could also be caught from discrete areas in the lake (e.g., with a purse seine) and tagged, but this is not included in the present study. Recovery of tagged salmon at the Cedar River trap and other spawning areas would indicate the spatial distribution patterns of the salmon.

In addition to these directed research projects, the number of non-Cedar River fish caught would need to be compared to escapements to determine if harvest occurs at unsustainable levels. The combination of these methods would provide strong evidence of the extent to which area closures or timing restrictions are likely to protect non-Cedar River populations. It should be noted that the known beach spawning populations in the lake are quite small (often only 100's of individuals) and that they spawn within the current fishing area. While the pre-spawning timing and distribution of lake spawning sockeye is unknown, there is concern that these small populations could be subjected to harvest rates that are too high through incidental capture during fisheries targeting Cedar River sockeye. These spawning grounds should be surveyed systematically each year.

The tagging studies should occur for up to four years, starting as soon as possible. Further study years should occur in conjunction with changes in harvest regulations.

Specifically, in years that regulations are modified, fish harvest should be examined for their population of origin to determine the effectiveness of the new regulations at protecting non-Cedar River fish.

Straying

The results of studies conducted to date indicated that it is unlikely that significant numbers of Cedar River sockeye will stray into other parts of the Lake Washington basin, so this is a much lower priority than studies related to adult arrival, in-lake movements and escapement counts. However, periodic sampling of sockeye otoliths should occur to look for evidence of hatchery-produced fish in all the sockeye salmon spawning grounds in the basin in association with general spawning ground surveys. The study years will depend upon the realized production increases and will be decided by the program management participants.

Budget

A total of $946,400 was allocated to adult survival, distribution, and homing studies for the life of the HCP. Of that $47,320 was allocated for each year in years 1-8 and $35,490 in years 9-10. Table 2-14 presents the budget allocations for studies of harvest and straying.

TABLE 2-14.
BUDGET ALLOCATION FOR HYPOTHESES RELATED TO EFFECTS TO OTHER LAKE WASHINGTON BASIN SOCKEYE POPULATIONS FOR THE FIRST 8 YEARS

		HCP Allocation		AMP		
Hypothesis	HCP Budget Category	Years	Amount[a] (per year)	Years[b]	Estimated Cost (per year)	Comments
Harvest of non-Cedar River sockeye	Adult survival, distribution, and homing studies	1-15 21-50	$47,320	1-4	$100,000	Tracking, tagging, and harvest studies
Straying of Cedar River sockeye	Adult survival, distribution, and homing studies	1-15 21-50	$47,320	6, 8, 10	$15,000	

a. Total amount allocated to all activities within that budget category, first 8 years.
b. Study years within the first ten years of the hatchery only. Further studies will be decided through analysis of study results.

2.3.6 Adaptive Management Actions

Harvest

Potential Study Outcomes

Potential outcomes of this hypothesis study include:

1. Observed or projected harvest levels of non-Cedar River sockeye populations during Lake Washington fisheries are sustainable.
2. There is observed or projected harvest of non-Cedar River sockeye populations in Lake Washington fisheries that is not sustainable.

Threshold

If escapement levels of sockeye to Bear Creek have a statistically greater tendency to drop below the historic minimum escapement range in years of harvest compared to years of no harvest, then the process described in Section 4.8 will be followed to determine cause and responsive action.

With this study, the undesirable outcome would be significant (unsustainable) harvest of sockeye populations other than the Cedar River, or fisheries that capture a very discrete fraction of the Cedar River population. Table 2-15 lists the potential causes of non-Cedar River sockeye harvest population and possible methods of correction.

TABLE 2-15.
FACTORS THAT COULD CONTRIBUTE TO HARVEST OF NON-CEDAR RIVER SOCKEYE AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Ineffective fishing regulations due to spatial location of sockeye populations in the lake.	Study the spatial locations of different sockeye populations throughout their time in the lake.
Ineffective fishing regulations due to timing of different sockeye populations passing through the lake.	Study the timing and location relationships between different sockeye runs in the basin. Modify harvest regulations accordingly.
Intermixing of sockeye from different populations while in the lake.	Recommend harvest regulation changes to co-managers to reduce harvest rates or shift fishing to a time when populations are more separated.

Straying

Potential Study Outcomes

Potential outcomes of this study include:

1. There is no significant straying of Cedar River sockeye into other basin spawning areas.
2. There is significant straying of Cedar River sockeye into other basin spawning areas.

Threshold

During the first 10 years, a sample of 100 otoliths should be obtained from the Bear Creek populations biannually and examined for patterns indicating hatchery origin. If 5 or more hatchery fish are detected in the sample more than twice in the 10-year period, or if 7 or more hatchery fish are detected in any year, the process described in

Section 4.8 will be followed to discuss the possible causes of the elevated straying and plan steps to reduce it.

With this study, the undesirable outcome would be significant straying of Cedar River fish. Table 2-16 lists the potential causes of straying and possible methods of correction. It is not clear exactly what level of straying of hatchery fish into these populations would constitute a problem. Levels on the order of 1 to 2 percent of the recipient population seem to occur in natural populations (Quinn 1993). NOAA Fisheries stated that two or three successful migrants per generation may be an acceptable target or limit on the straying of Cedar River hatchery fish into Bear Creek (Memo Waples to Robinson, July 24,1998). Other NOAA Fisheries work has viewed straying rates of up to 5 percent of the receiving population as a limit (NOAA Fisheries, 1995).

TABLE 2-16.
FACTORS THAT COULD CONTRIBUTE TO STRAYING OF CEDAR RIVER SOCKEYE AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Low release site in the river (insufficient experience for imprinting)	Release hatchery fry further upstream from current locations.
Increased relative production of Cedar River fry.	Decrease production levels. Make recommendations to co-managers that will cause harvest of excess adults returning to Cedar River.

2.4 UNCERTAINTY NO. 4—WILL THE HATCHERY PRODUCE ADVERSE CHANGES IN CHINOOK SALMON POPULATIONS?

2.4.1 Definition and Importance

The sockeye salmon hatchery is designed to be benign with respect to other salmonids in the Cedar River. Chinook salmon, one of the other salmonid species in the basin, are part of the Puget Sound Chinook Evolutionarily Significant Unit that is listed as threatened under the Endangered Species Act (ESA). Chinook and sockeye salmon characteristically use different spawning habitats but sympatry, as observed in the Cedar River, is not unprecedented. It is essential that the hatchery not adversely affect the chinook salmon population.

There are several possible modes of interaction between the sockeye hatchery and the chinook salmon population. First, the broodstock collection facility might deter or delay upstream migration (hence distribution, habitat use, and reproductive success) of chinook salmon. Second, large numbers of sockeye salmon returning to the river might disturb the redds of chinook salmon. It is important to note that increased sockeye numbers are not simply a hatchery-related effect but instead are an effect of the mitigation levels identified in the LMA, which is intended to increase the number of sockeye in the river. Lastly, there might be complex ecological interactions involving other species, such as an increase in sockeye salmon fry buffering chinook salmon

against predation or sockeye fry serving as a chinook prey item. This last interaction is addressed in Uncertainty No. 5.

2.4.2 Existing Data and Knowledge

Researchers from the City, WDFW, and King County have been conducting studies on chinook spawners in the Cedar River since 1999. Figure 2-2 illustrates the distribution of chinook redds in 1999 and 2003 by river mile (RM). Most chinook salmon spawned above the present location of the broodstock collection weir (RM 6.5) in 1999, 2000 and 2001 (Burton et al. 2001). Twenty nine per cent of the river lies below the location of the broodstock collection weir.

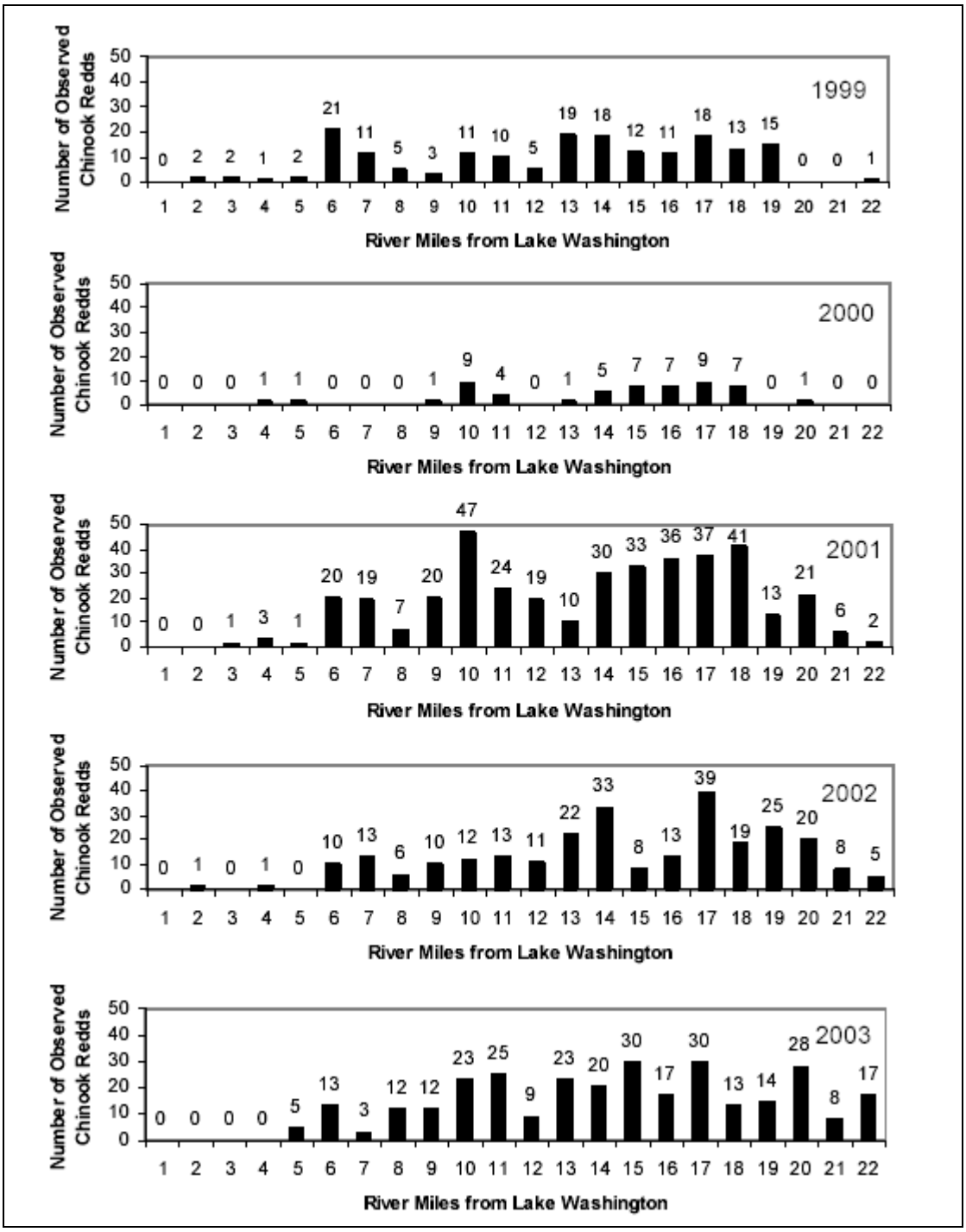


Figure 2-2. Chinook Redd Distribution by River Mile, Cedar River 1999 and 2003 (from Burton et al. 2004).

In 2003, 19 redds (6 percent of the 301 total redds) were noted downstream of the broodstock collection weir. In 2002, 20 redds (7 percent of the 281 total redds) were observed below RM 6.5. In 2001, 36 redds (9 percent of the 398 total redds) were found below the broodstock weir. In 2000, only two redds (4 percent of the 53 total redds) were identified below RM 6.5, while in 1999, 35 redds (19 percent) of the 180

total redds were observed below the weir. (Burton et al. 2004). This suggests that present collection facilities and their operations do not greatly disrupt upstream distribution.

Studies have also been undertaken on the spawning times of sockeye and chinook. The spawning periods of sockeye and chinook salmon overlap broadly, though the sockeye tend to spawn later and over a longer period at present (Figure 2-3; Cascade Environmental Services 1995; Burton et al. 2001). Thus later redd excavation by sockeye might disturb chinook redds.

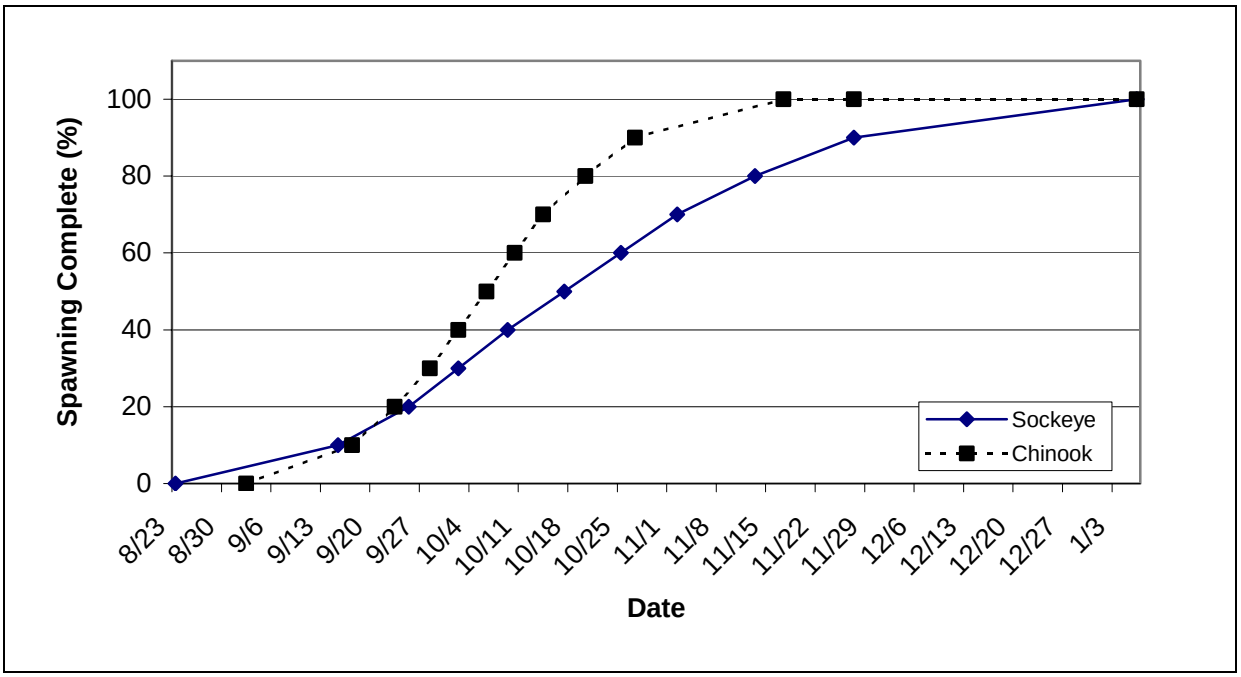


Figure 2-3. Average Historical Spawning Curves for Chinook and Sockeye Salmon in the Cedar River (Cascade Environmental Services 1995)

In 1999, the City, WDFW, and King County made observations about sockeye superimposition on chinook redds. Of the 180 chinook redds observed in 1999, five were observed to experience sockeye spawning activity within close proximity and one chinook redd experienced sockeye redd superimposition. Based on these observations, weekly observations were made in 2000 for 52 out of 53 chinook redds to determine the proximity and extent of sockeye spawning near (within 20 feet) incubating chinook. Twenty-two (42 percent) of the observed redds in 2000 had no sockeye spawning activity within 20 feet of their redd mounds. Twenty-four chinook redds (46 percent) had at least one sockeye redd within 20 feet of their mounds. Sockeye spawned directly on the mounds of six chinook redds (11 percent of the observed chinook mounds; Burton et al. 2001).

The extent of chinook redd damage from sockeye spawning activities is unclear. Egg burial depth is positively correlated with body size (Steen and Quinn 1999), so the embryos of larger chinook salmon might not be greatly disturbed by the digging of smaller sockeye salmon. To assess this possibility, the likely egg burial depth of Cedar River sockeye and chinook salmon were estimated from body size data. The chinook

female fork length average was estimated at 772 mm, based on unpublished data provided by Larry Lowe, WDFW. These data, collected as post-orbit to hypural lengths, were adjusted to fork length using the regression relationship reported by Roni (1992). Using the length-egg burial relationship reported by Steen and Quinn (1999), an average egg burial depth of 22.8 cm for the chinook salmon was estimated. A fork length of 565.5 mm for sockeye salmon was used based on an average of 460 mm mid-eye to hypural length, estimated from data provided by Karl Burton (City of Seattle), Kurt Fresh (WDFW) and Andrew Hendry (University of Massachusetts). The sockeye average egg burial depth was estimated to be 16.7 cm. This is a difference of 6.1 cm in burial depth. However, these estimates are subject to considerable error, as indicated in the reports by Steen and Quinn (1999) and DeVries (1997). It is unclear if a difference of 6 cm is sufficient to protect chinook eggs from damage by sockeye digging.

Cedar River chinook fry are thought to exhibit an ocean-type life history, which typically includes a protracted downstream migration. Fry trapping conducted at the mouth of the Cedar River for sockeye also includes chinook fry and smolt sampling. Trapping is continued through July to adequately trap chinook and understand their timing.

2.4.3 Remaining Unknowns

Will the new broodstock collection facility affect the spawning distribution and reproductive success of chinook salmon?

Since the listing of chinook under the ESA, measures have been taken to avoid delaying their migration at the current weir location. One of the measures includes opening several sections of the weir for fish passage when a chinook is seen holding downstream of the weir. After a chinook is seen holding downstream of the weir for 24 hours, the weir is opened until the chinook passes the weir, or for a period of 12 hours (WDFW 2001). Due to the desire to minimize delay of chinook and to the high number of chinook in the river in 2001, practices often exceeded these protocols. During the 2001 broodstock collection period, the weir was usually opened when chinook were seen in the vicinity of the weir and during some periods the weir was open all night (Brodie Antipa, WDFW, pers. comm.). Data from 1999 and 2000 also suggest that the weir has not significantly delayed chinook migration, based upon their redd location distribution.

However, the replacement hatchery will have a new broodstock collection facility lower on the river. The new facility might affect chinook migration timing and spawning distribution. It is unclear how to determine whether chinook salmon are being delayed, unless they are seen holding below the weir. Perhaps the more important question is whether their spatial distribution is similar to that observed recently (which would assume there is currently no blockage at the weir). The most serious evidence of a problem would be the observation of pre-spawning mortalities of chinook salmon below the weir or much higher densities below the weir than farther upriver.

What is the effect of sockeye redd superimposition on chinook redds?

Based upon the above estimates of chinook and sockeye redd excavation depths, it is unclear if sockeye redd superimposition has significant effects on chinook eggs. The tendency of female salmon to use redd sites excavated by other females, including those of other species (Essington et al. 1998) is known but poorly understood. The critical question is, if smaller salmon (e.g., sockeye) use redd sites containing eggs buried by larger salmon (e.g., chinook), will the eggs of the larger salmon be disturbed or destroyed? The limited literature on inter-specific and intra-specific density dependence in spawning grounds suggests that this is not a simple matter. In the Weaver Creek Spawning Channel, the reproductive success of pink salmon was not affected by densities of sockeye or chum salmon, even though the latter two species were both larger and spawned later than the pink salmon (Essington et al. 2000). Finally, it should be noted that the hatchery is not projected to increase densities of sockeye salmon spawning in the river beyond those set by the present escapement goal.

2.4.4 Hypotheses

The following hypotheses will guide initial research studies related to this uncertainty:

- Operation of the broodstock collection facility does not significantly delay chinook migration or alter spawning distributions.
- There is no significant damage to incubating chinook eggs from sockeye superimposition on chinook redds or reduced chinook reproductive success.

2.4.5 Monitoring and Research Plan

Chinook Migration and Spawning Distribution

The new broodstock collection facility will need to be monitored to ensure that it does not affect chinook passage. Studies on the spatial distribution of chinook spawning should occur during the first several years of the new facility's operation, and the patterns should be compared to those observed during the past few years. The distribution studies could be similar to current methods, which consist of regular floats of the Cedar River to locate and record chinook redds during the spawning season. In addition, records should be kept at the broodstock collection facility of chinook seen holding downstream and their time of passage, as well as a count of the number of chinook salmon migrating past the collection facility. These records will help evaluate chinook passage times and validate counts in the river. While the count data is not strictly related to the sockeye salmon hatchery, it will be important for determining possible effects of the increase in sockeye numbers on chinook salmon. Chinook and sockeye spawning surveys, along with collection facility observations, should occur annually in years 1-8.

Chinook Redd Superimposition and Reproductive Success

It is neither practical nor acceptable to excavate chinook salmon redds in the Cedar River to determine if there was actual disruption by sockeye salmon digging.

Nevertheless, the issue of redd disturbance should be investigated. Initial studies could examine the relationship between the number of chinook fry per female and sockeye densities. Existing data from chinook and sockeye spawning surveys and fry trapping should allow for such a study. Future annual counts of chinook salmon or their redds and fry counts will also be important as hatchery production and sockeye escapement increase.

Observations of sockeye-chinook interactions on the spawning grounds should also be continued. Through annual records of sockeye superimposition on chinook redds, relationships between sockeye abundance and chinook redd superimposition rates can be followed as hatchery production and sockeye escapement increases.

Studies should occur annually in years 1-8 (in conjunction with fry trapping studies discussed under Uncertainty No. 1). Beyond year 8, studies should occur at various levels of sockeye escapement and hatchery production.

Budget

The Monitoring and Research Program did not allocate funds for chinook salmon studies. Current funding for the recommended activities is supplied by WDFW, the City, and King County. Table 2-17 provides a breakdown of the budget amounts for chinook studies on the Cedar River.

TABLE 2-17.
BUDGET ALLOCATION FOR HYPOTHESES RELATED TO EFFECTS OF THE BROODSTOCK COLLECTION FACILITY AND INCREASED NUMBERS OF SOCKEYE ON CHINOOK REDDS IN THE CEDAR RIVER FOR THE FIRST 8 YEARS

		HCP Allocation		AMP		
Hypothesis	HCP Budget Category	Years	Amount[a] (per year)	Years[b]	Est. Cost (per year)	Comments
Chinook Migration and Spawning Distribution	None	—	—	1-8	$35,000[c]	Chinook observations at the broodstock collection facility should be integrated into collection protocols.
Chinook Redd Superimposition and Reproductive Success	None	—	—	1-8	$40,000[d]	Chinook trapping is conducted with sockeye fry trapping. Adult chinook estimates and observations would be funded through the float surveys (above row).

a. Total amount allocated to all activities within that budget category, first 8 years.
b. Study years within the first ten years of the hatchery only. Further studies will be decided through analysis of study results.
c. Estimate is for float surveys only. Funding was $25,000 in 2001, provided by the Instream Flow Committee under the HCP. In 2002, $27,500 will be provided by a King ~~County~~ Conservation District grant, with the remainder supplied by the City.
d. This is current amount allocated for sockeye fry trapping under the HCP. The total cost is approximately $80,000, which includes trapping for all species and WDFW overhead. The remaining $40,000 of the cost is provided by WDFW and King County.

2.4.6 Adaptive Management Actions

Chinook Migration and Spawning Distribution

Potential Study Outcomes

Potential outcomes of this study include:

1. There is no significant delay of migrating chinook at the broodstock collection facility or alteration of spawning distribution.
2. There is a significant delay of migrating chinook at the broodstock collection facility or alteration of spawning distribution.

Threshold

Observations by observers at the broodstock collection facility indicating that more than 5 percent of the chinook that return in a given year are delayed by one day or more will be taken as evidence of delay, and will result in initiating the process described in Section 4.8 to determine the cause and recommend remedial actions. Changes in the spatial distribution of chinook spawning will be inferred from frequency distributions by river mile. There is considerable year-to-year variation (e.g., Figure 2-2). Some changes in distribution might not be consequences of hatchery operations, and some might not be deleterious. However, an increase in chinook salmon spawning below the weir relative to the number spawning above would be cause for concern. A statistically significant increase in the proportion of chinook spawning below the weir will result in initiating the process described in Section 4.8 to determine the cause and recommend remedial actions.

The undesirable outcome would be a significant delay of chinook at the collection facility, as well as an overall change in the distribution of chinook redds in the river. Table 2-18 lists the potential causes of chinook delay and possible methods of correction.

TABLE 2-18.
FACTORS THAT COULD CONTRIBUTE TO DELAY OF MIGRATING CHINOOK AND A CHANGE IN SPAWNING DISTRIBUTION AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Infrequent collection facility openings.	Modify weir operational protocols to promote rapid passage of chinook.
Trap shyness on the part of the chinook.	Modify the facility to minimize the effect on chinook.

Chinook Redd Superimposition and Reproductive Success

Potential outcomes of this study include:

1. There is no significant damage to incubating chinook eggs from sockeye superimposition on chinook redds and no change in chinook reproductive success.
2. There is significant damage to incubating chinook eggs from sockeye superimposition on chinook redds and a decline in chinook reproductive success.

Threshold

The production of chinook salmon fry and fingerlings from the river is likely to be a function of the number of spawners in the parental generation and the peak flow in the river during the incubation period. A decrease in fry production, after accounting for these variables, or an inverse correlation between fry production and sockeye salmon density in the river will result in initiating the process described in Section 4.8 to determine the cause and recommend remedial actions.

The undesirable outcome would be significant damage to chinook eggs from sockeye redd superimposition. Table 2-19 lists the potential causes of chinook redd superimposition and decreased chinook reproductive success.

TABLE 2-19.
FACTORS THAT COULD CONTRIBUTE TO SOCKEYE REDD SUPERIMPOSITION ON CHINOOK REDDS AND DECLINING CHINOOK REPRODUCTIVE SUCCESS AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Increase in the number of sockeye spawners or preponderance of late spawning by sockeye.	Alter release locations of hatchery fry or adjust fisheries to keep the escapement close to the goal. The sockeye escapement goal might have to be reduced.

2.5 UNCERTAINTY NO. 5—WILL INCREASED HATCHERY PRODUCTION ALTER AQUATIC COMMUNITY STRUCTURE WITHIN THE LAKE WASHINGTON SYSTEM?

2.5.1 Definition and Importance

Lake Washington serves as the nursery lake for Cedar River sockeye. The lake is a critical transition habitat between the incubation grounds in the Cedar River and other tributaries, and ocean feeding grounds. Hatchery production is expected to increase the number of juvenile sockeye salmon in the lake and this may affect the lake aquatic community. These effects might have ramifications for the hatchery population, other sockeye salmon populations in the basin, and other organisms in the community. These kinds of effects are difficult to predict because of the complex interactions among trophic levels, uncertainty about the factors controlling the abundance of various components of the community, and uncertainty about the future trends in physical factors that might affect the ecosystem. The most obvious ecological interactions involve density, competition and predation.

As stated previously, it is important to acknowledge that an increase in the number of sockeye in the Cedar River and Lake Washington is the intent of the LMA and more generally by the management goals of the co-managers, regardless of whether it is achieved with a hatchery, a spawning channel, or from increased habitat above Landsburg Dam. Therefore, the potential effects on the Lake Washington ecosystem cannot be simply attributable to hatchery operations, and must be considered in relation to the LMA.

2.5.2 Existing Data and Knowledge

Most of the existing data and knowledge about the Lake Washington ecosystem and its relationship to sockeye are referred to in the background portion of this collection of documents. The following is a brief synopsis of the major important interactions.

- The zooplankton *Daphnia* is the preferred prey item of sockeye in Lake Washington for most of the year.
- *Daphnia* abundance and size, as well as their relationship to thermal regimes and other zooplankton in Lake Washington, has been studied largely by the University of Washington's Department of Zoology. The abundance of *Daphnia* varies seasonally, being scarce in the winter until about April and then being abundant through the fall.
- *Daphnia* are also preyed upon by other fish species, notably longfin smelt and threespine sticklebacks, and one invertebrate predator, *Neomysis mercedis*.
- Smelt prey upon *Daphnia* and thereby compete with sockeye for that resource. However, smelt also prey upon *Neomysis* and reductions in *Neomysis* density appear to release *Daphnia* from strong predation pressures, allowing more food for sockeye. Smelt also seem to buffer predation on sockeye by cutthroat trout (Nowak et al. 2004) and perhaps other piscivorous fish in the years that smelt are abundant.
- Sockeye are preyed upon by many species of predatory fishes, including prickly sculpins, northern pikeminnow (formerly known as northern squawfish), and cutthroat trout. Of these, the trout may be the most important at present and their population seems to have increased over the past decades.

2.5.3 Remaining Unknowns

What is the carrying capacity of Lake Washington for sockeye fry?

Food resources are important because all ecosystems have finite carrying capacities and overabundance of sockeye salmon could reduce the abundance or size distribution of their food resources (chiefly cladocerans and copepods), leading to reduced growth and survival in the lake or at sea. The growth rate of sockeye salmon in the lake is a function of temperature, food quantity and quality, and fish size. In many lakes, the growth of sockeye salmon is density-dependent (see Burgner's 1987 and 1991 reviews). Evidence for the consequences of exceeding the carrying capacity of a lake was provided by the experiments on Leisure Lake, Alaska (Koenings and

Burkett 1987). Increasing densities of sockeye salmon fry resulted in progressively smaller smolts, a higher proportion of the smolts leaving the lake after two rather than one year of lake residence, and a smaller total smolt biomass. Thus concern about exceeding the carrying capacity of a sockeye salmon rearing lake has basis in experience. However, some attributes of Lake Washington make it different from other sockeye salmon lakes.

The density of sockeye salmon spawning in the Lake Washington basin (expressed as the number of adult salmon per square kilometer of lake area) has not been especially high (Burgner 1991), and the total of the current escapement goal plus the 262,000 adult mitigation level would leave it well within the range for the species (Figure 2-4). In addition, the sockeye salmon smolts from Lake Washington are at the upper end of the range of sizes seen in natural populations in North America (Figure 2-5; Burgner 1991). This growth may result from both the comparatively mild thermal regime and high density of large prey, notably *Daphnia*.

The central question is, "What density of sockeye salmon would depress food resources, leading to reduced growth and subsequent survival of sockeye or other ecologically important species in the lake?" Research in other lakes has indicated that larger smolts are more likely to survive at sea than smaller smolts (Henderson and Cass 1991; Koenings et al. 1993). However, within a given lake, relatively little of the year-to-year variation in marine survival is explained by smolt size. Rather, the larger smolts within a year class enjoy a higher probability of survival than smaller smolts, and lakes with smaller smolts tend to have lower survival rates than lakes with larger smolts. Therefore, while smolt sizes between lakes seem to affect marine survival, it appears that year-to-year variation within a lake system does not greatly affect smolt survival. Indeed, there is even evidence that marine survival may be lower for very large smolts than for those of intermediate sizes (Koenings and Burkett 1987). Nevertheless, decreases in smolt size should trigger concern, especially if accompanied by decreases in survival rates or shifts in age composition.

What is the effect of increased numbers of sockeye on piscivore populations?

In examining predator responses to increased sockeye populations, there might be short-term (i.e., behavioral) responses and long-term (numerical) responses. In the short term, increased abundance of sockeye salmon fry might be expected to decrease per capita predation if the number of predators and the number of prey eaten per predator were fixed. However, if the predators congregated at the mouth of the Cedar River to a greater extent than they do at present or in some other way modified their behavior to "specialize" on sockeye salmon then predation per individual sockeye might not decline. In the longer term, if the abundance of sockeye salmon as prey increased the growth rate or abundance of predators then the increase in fry abundance might be compensated by increased predation. The likelihood of this possibility will depend on the factors controlling abundance of predators but should be considered, at least conceptually.

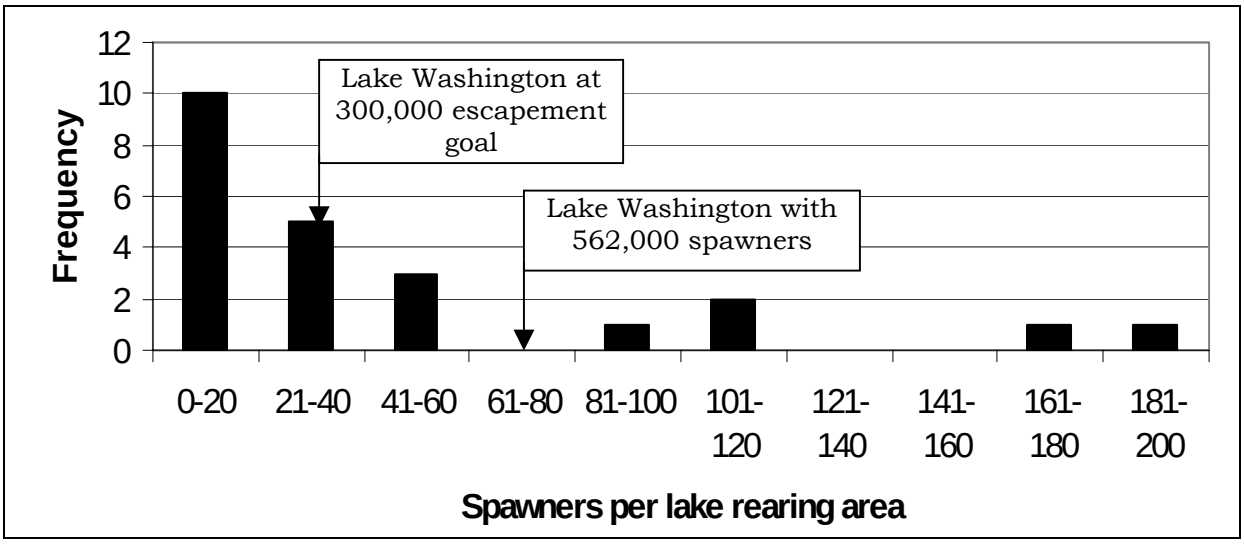


Figure 2-4: Frequency of Lake Spawning Densities for Lakes in the Pacific Northwest, British Columbia, Alaska, and Russia (From Burgner 1991).

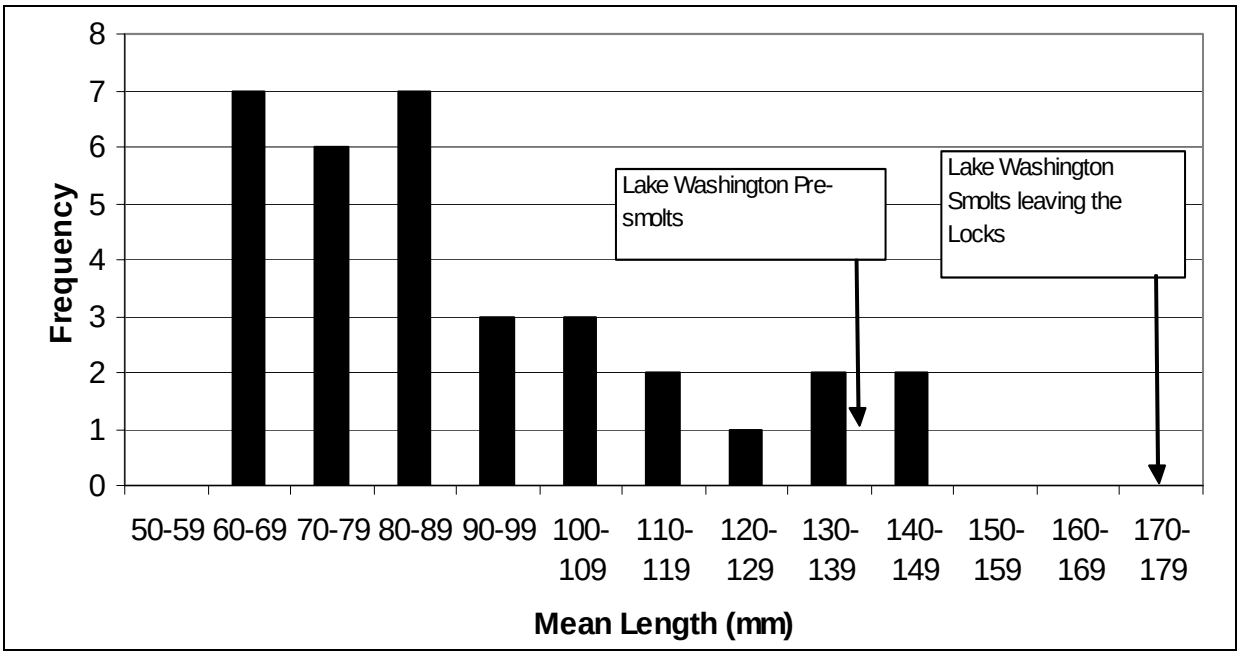


Figure 2-5: Frequency of Average Sockeye Smolt Sizes for Nursery Lakes in the Pacific Northwest, British Columbia, Alaska, and Russia (from Burgner 1991, and unpublished data from K. Hyatt, DFO, Nanaimo, B.C., and Cary Feldmann, Puget Sound Energy, personal communication).

How does the abundance of sockeye affect other planktivorous fish?

An increase in sockeye numbers in Lake Washington might also affect competitor species, specifically smelt. The effects that smelt and sockeye have on each other are complicated and cannot be well predicted. An increase in the number of sockeye, and their depletion of prey, could cause a decline in the smelt population. In addition, smelt populations could further be reduced through sockeye-induced predation

increases. These reduced smelt populations could subsequently affect sockeye through prey reduction (since the *Neomysis* population would presumably not be controlled and would consume more *Daphnia*) and decreased prey buffering. The situation is further complicated by the tendency of smelt to have a strong year class followed by a weak one. This makes it more difficult to detect ecological effects and relationships in the lake. In summary, the effects of sockeye upon smelt, and the ramifications for the sockeye population, are unknown and could limit the extent to which increased sockeye production is effective at increasing adult returns. Interactions with the lake's sticklebacks are even less well understood.

2.5.4 Hypotheses

- There is no relationship between sockeye abundance, growth and pre-smolt size in Lake Washington.
- There is no relationship between sockeye abundance and the abundance of predatory fish in Lake Washington.
- There is no relationship between sockeye abundance and the abundance of other planktivorous fish species.

2.5.5 Monitoring and Research Plan

Sockeye Growth

Growth of sockeye in the lake should be examined at various levels of sockeye density. By comparing fry abundance estimates and pre-smolt abundance and size estimates, a relationship between density and growth should be determined. The general description of these methods is discussed under Uncertainty No. 1.

It will be important to include assessment of zooplankton abundance and composition, as well as lake thermal regimes, to be able to account for any variability due to these factors. Abundance of other planktivorous species should also be incorporated since they will influence prey abundance and availability.

Sockeye density and growth data collection should be conducted annually in the first 10 years to track this relationship as hatchery production increases and to account for annual variation. Further study years will be determined through initial study results and direction of program management groups. In general, sampling of pre-smolts and other limnetic fishes is considered part of the baseline assessment needed for the lake.

Predation

It would be very difficult to establish reliable population estimates for fish predators in Lake Washington. Indirectly, predator abundance can be indexed by monitoring the survival of fry to pre-smolt over time. Whether predation will be studied in greater depth, depends on the level of uncertainty associated with predation and that will be determined through the process of establishing monitoring priorities. It is also possible that other entities may see the need for additional information about predator abundance and that this adaptive management program will collaborate with others. Establishing estimates of the major predators in the lake could allow calibration

between predator abundance and catches using cheaper, standardized sampling gear (e.g., gill nets for cutthroat trout, northern pikeminnow, and yellow perch; or electrofishing for bass, etc.). This would enable managers to relate catch rates from lower level monitoring efforts back to abundance. If predator studies are done, cutthroat trout, prickly sculpin, northern pike minnow are a few of the species that should be targeted for abundance estimates. A combination of trawl and hydroacoustic methods could be used. Further data that could be useful are seasonal distributions of these fish and overlap in space and time with sockeye, smelt and stickleback.

Planktivore Abundance

The abundance of other planktivorous fishes such as smelt and stickleback should be evaluated to determine how they might be affected by increased sockeye numbers. In addition, information about their abundance could assist in understanding how all lake planktivores cumulatively affect prey species in the lake. It would be possible to look at the relationship between the density of planktivores and the density of their prey, or the density of prey and growth of planktivores. Again, a combination of trawl and hydroacoustic methods should be used as part of the pre-smolt survey and in the fall as well.

To compare data between these three hypotheses, this study should also be conducted annually in years 1-10 to track changes in the planktivore population as hatchery production increases.

Budget

Funding to address issues related to uncertainties in the lake's carrying capacity and community is designated for year-round studies of the lake's plankton in years 1-4 at $47,320 in 2001 dollars, and springtime sampling of plankton at $8,281 annually for years 5-10, and $16,562 in total for years 11-15. It is recommended that these budget allocations assist with pre-smolt estimates for sockeye abundance and size data, as well as support some predator and planktivore studies. The planktivore studies could be combined with pre-smolt surveys. Table 2-20 provides a breakdown of budget amounts.

2.5.6 Adaptive Management Actions

Sockeye Growth

Potential Study Outcomes

Potential results of these studies include:

1. There is no relationship between sockeye abundance, growth and pre-smolt size in Lake Washington.
2. Increased sockeye abundance is associated with decreased growth and pre-smolt size in Lake Washington.

TABLE 2-20.
BUDGET ALLOCATION FOR HYPOTHESES RELATED TO LAKE WASHINGTON ECOSYSTEM EFFECTS FROM INCREASED SOCKEYE NUMBERS FOR THE FIRST 10 YEARS

		HCP Allocation		AMP		
Hypothesis	HCP Budget Category	Years	Amount[a] (per year)	Years[b]	Est. Cost (per year)	Comments
Sockeye Growth	Plankton Studies	1-4 5-10	$47,320 $8,281	1-10	$45,000	Includes zooplankton, and temperature studies. Pre-smolt estimates are conducted by WDFW. Should they be discontinued, funding should be allocated to that as a priority (see costs in Table 2-3).
Predation rates	None	—	—	Unknown	Unknown, depends on scope	Indirect assessment of predation through calculation of in-lake survival of fry to pre-smolt done annually
Planktivore Abundance	None	—	—	1-10	$19,000	Coincident with pre-smolt surveys.

a. Total amount allocated to all activities within that budget category, first 10 years.
b. Study years within the first ten years of the hatchery only. Further studies will be decided through analysis of study results.

Threshold

Every five years, a regression analysis will determine if there has been a significant decline in sockeye smolt size over time [α=.05]. If a significant decline is established, further analysis will be done to determine if food supply has changed, whether the declining trend correlates with lower freshwater or saltwater survival and whether the annual variation in size correlates with sockeye fry abundance. Based on these analyses and others deemed appropriate by the TWG, the TWG will determine if the development of responses as described in Section 4.8 should be initiated. ~~There is no significant relationship between sockeye abundance and pre-smolt size in Lake Washington when analyzed every five years. If a significant relationship is found, then the process described in Section 4.8 will be followed to determine cause and responsive actions.~~

The undesirable outcome would be decreased size and growth, correlated with increased marine or in-lake mortality for sockeye. Table 2-21 presents possible factors contributing to this relationship and possible methods of correction. It is important to keep in mind that the food web interactions in Lake Washington are complex and it will be difficult or unwise to try any correction methods other than changes in hatchery production.

Predation Rate

Potential Study Outcomes

Findings for this hypothesis could include:

1. There is no relationship between sockeye abundance and the rate of predation in Lake Washington.

TABLE 2-21.
FACTORS THAT COULD CONTRIBUTE TO DECREASED SOCKEYE GROWTH AND SIZE IN LAKE WASHINGTON AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
The carrying capacity of the lake is being exceeded.	Reduce hatchery production to levels that are in balance with the lake's prey base and other planktivores.
Temperature of the lake is increasing metabolic costs.	Temperature in the lake has been getting warmer over the past few decades. The mix of global and local causes has not been determined, much less the correction method.

2. There is a relationship between increased sockeye abundance and increased predation rates on salmonids in Lake Washington.
3. There is a relationship between increased sockeye abundance and decreased predation rates on salmonids in Lake Washington.

Threshold

[The following assumes that chinook PIT tagging at the Cedar River will continue and that an index of survival associated with predation can be developed] If a significant relationship is established between predation rates (3-year rolling average), as indicated by PIT tagging and detection of chinook smolts between the Cedar River and the Ballard locks and sockeye abundance (as measured by pre-smolt estimates on the year of outmigration), then the process described in Section 4.8 will be followed.

If fry to pre-smolt survival drops below the historic range for two years out of five, the adaptive management review process described in Section 4.8 will be initiated.

The undesirable outcome would be a correlation between increased numbers of sockeye and increased rate of predation on them. Table 2-22 presents possible reasons for this predatory increase and possible methods of correction.

TABLE 2-22.
FACTORS THAT COULD CONTRIBUTE TO RATE OF PREDATION IN LAKE WASHINGTON AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Increase in the number of sockeye fry.	Reduce production in the hatchery; adjust release strategy.

Planktivore Abundance

Potential Study Outcomes

The possible outcomes of this hypothesis are:

1. There is no relationship between sockeye abundance and the abundance of other planktivorous fish species.
2. Increased sockeye abundance is associated with altered abundance of other planktivorous fish species.

Thresholds

If a significant relationship is established between sockeye abundance and smelt abundance when analyzed over a 10 year period and taking into account the biennial variation in smelt abundance, then the process described in Section 4.8 will be followed.

If a significant inverse relationship is established between sockeye abundance and smelt size, while taking into account the two-year cycle for smelt abundance, then the process described in Section 4.8 will be followed.

The undesirable outcome would be an increase in sockeye and a decrease in other planktivores (i.e., smelt and stickleback). Table 2-23 presents possible factors contributing to the reduced number and possible means of correction. It is unclear how changes in body size or abundance of such competitors should be viewed in the absence of observable effects on sockeye salmon. The smelt population varies greatly in abundance between odd-numbered and even-numbered years, and the mean lengths vary inversely, indicating competition for food. If the increase in sockeye salmon abundance was associated with decreased smelt body size, it would indicate changes in the lake ecosystem. If this occurs, the AMP will need to consider whether hatchery operations should be modified. However, the longfin smelt population is apparently not a native one, or at least their presence was undetected until the mid-1900s, so changes in their abundance are not necessarily of great concern.

TABLE 2-23.
FACTORS THAT COULD CONTRIBUTE TO DECREASED ABUNDANCE OF LAKE WASHINGTON PLANKTIVORES (OTHER THAN SOCKEYE) AND POSSIBLE METHODS OF CORRECTION

Factor	Method of Correction
Reduced prey availability.	The cause of the prey reduction would need to be determined. Increased competition with sockeye for food might be the cause. If so, is the effect substantial enough or of great enough concern to alter hatchery production? If so, then hatchery production should be decreased until a stable balance can be found between the number of sockeye and other lake planktivores.
Increase in predation rate .	The cause of increased predation rates on salmonids would need to be determined. If it is a response to increased prey base, mainly through increased sockeye numbers, it would need to be determined if the effect was substantial enough to warrant modification of hatchery production.

SECTION 3.
ADAPTIVE MANAGEMENT SUMMARY

Table 3-1 presents the five major uncertainties, the proposed initial hypotheses to be tested, potential study outcomes for each hypothesis, and potential management responses to unfavorable outcomes. Proposed thresholds included in the discussion of hypotheses for each uncertainty in Section 2 will undergo further review by the Independent Science Advisors and Technical Working Group, and may change during the implementation of the AMP. Determination of threshold exceedence will be determined by the TWG and confirmed by the ISA, in cases where professional judgement is the primary basis for the decision.

Some of the ecological outcomes could be affected by multiple causes, including some that are independent of the hatchery program. Therefore, it is important to note that an assessment of cause will be conducted when a threshold is reached. This process is intended to determine, insofar as possible, the underlying cause or causes of the change. Using available data and professional judgment, the TWG and the ISA will be asked to assess the likelihood that the hatchery program is a significant contributor to the measured effect. If the experts believe that this is the case, then the TWG and ISA, if needed, would be asked for recommendations for a response.

They will first determine if one of the predefined responses in Table 3-1 would be an effective action. If so, they can recommend it to the AMWG and parties for implementation. If not, the TWG can recommend alternatives including no response, further study or other actions. In making recommendations, the TWG will consider the risk to the resource of exceeding the threshold and become more conservative when there is a high risk. Recommendations would be reviewed by the AMWG and the parties would make the decision regarding the appropriate response. The process for evaluating cause, making recommendations and making decisions will be open to the public.

TABLE 3-1.
SUMMARY OF AMP UNCERTAINTIES, HYPOTHESES, POTENTIAL RESEARCH OUTCOMES, AND MANAGEMENT ACTIONS

Hypothesis	Potential Outcomes	Potential Response Actions
Uncertainty No. 1—Are hatchery and naturally produced fry similar in size, growth, and migration timing, and at a stable population composition?		
There is no difference in migration timing between hatchery and naturally produced fry.	1. No significant difference 2. Significant difference*	• Study egg take timing versus river spawning timing and alter broodstock collection as necessary. • Study egg density and development rate relationships and alter incubation densities or temperature as necessary.
Hatchery and naturally produced fry are similar in size.	1. No size difference 2. Significant size difference*	• Alter broodstock spawning and collection to account for females of different sizes. • Adjust release strategy for fry. • Change incubation conditions. • Alter temperature of incubation water.
At the time of pre-smolt surveys, there is no significant difference in size of hatchery and naturally produced fry.	1. No significant difference 2. Significant size difference*	• Examine and alter, if necessary, the fitness level of hatchery fry. • Adjust release strategy • Adjust timing of hatchery fry to more closely resemble the natural fry.
At the time of pre-smolt surveys, the proportions of hatchery and natural sockeye are similar to those estimated upon entering the lake as fry.	1. No significant difference 2. Significantly greater* 3. Significantly less	• Evaluate relative trends in key life stages, including fry-to-adult survival rates, to help determine when in life cycle impacts are occurring. • See corrective measures under pre-smolt size and growth and fry size.

Note: Potential response actions only address the undesirable outcomes, which are followed by an asterisk in the potential outcomes column.

TABLE 3-1 (continued).
SUMMARY OF AMP UNCERTAINTIES, HYPOTHESES, POTENTIAL RESEARCH OUTCOMES, AND MANAGEMENT ACTIONS

Hypothesis	Potential Outcomes	Potential Response Actions
Uncertainty No. 2—Does the hatchery reduce the reproductive success of Cedar River Sockeye Salmon?		
The size and age composition of the population at maturity of Cedar River sockeye will not show a trend over time.	1. No trend 2. Trend to decreasing size and increasing age* 3. Trend to increasing size and decreasing age	• Adjust number of smaller individuals spawned. • Adjust fry production. • Assess smolt size • Adjust release strategy
The relationships between body size, fecundity and egg size of female sockeye in the Cedar River will remain within a normal range.	1. Constant relationship 2. Reduction in egg size and fecundity* 3. Increase in egg size and fecundity	• Adjust number of smaller females spawned. • Adjust fry production. • Ensure broodstock is representative of the run.
The spatial and temporal distribution of spawning will remain within a normal range over time.	1. No significant difference 2. Significant difference*	• Alter broodstock collection timing to represent the entire run. • Shift broodstock collection practices to remove fish from the entire run. • Assess hatchery practices for unforeseen effects.
There will be no difference in reproductive success between hatchery and naturally produced sockeye spawning naturally or a trend in overall reproductive fitness over time as a result of fish culture practices.	1 Similar rates and no trend 2. No similarity in rates and a decreasing trend* 3. No similarity in rates and an increasing trend	• Alter spawning methods at the hatchery to more closely follow natural conditions. • Allow a higher proportion of natural spawning.
The genetic composition of the Cedar River sockeye population will not change over time.	1. No change 2. Change*	• Re-examine trapping and spawning protocols at the hatchery and fishery management.

Note: Potential response actions only address the undesirable outcomes, which are followed by an asterisk in the potential outcomes column.

TABLE 3-1 (continued).
SUMMARY OF AMP UNCERTAINTIES, HYPOTHESES, POTENTIAL RESEARCH OUTCOMES, AND MANAGEMENT ACTIONS

Hypothesis	Potential Outcomes	Potential Response Actions
Uncertainty No. 3—Will the hatchery adversely affect sockeye populations outside the Cedar River?		
Sockeye harvest in Lake Washington does not capture unacceptable numbers of non-Cedar River sockeye.	1. No significant harvest 2. Significant harvest*	• Recommend study of timing and spatial distribution of various populations while in the lake and adjust harvest locations. • Make recommendations to co-managers regarding harvest management.
There is no significant amount of Cedar River hatchery sockeye straying into other Lake Washington basin creeks.	1. No significant straying 2. Significant straying*	• Release hatchery fry farther upstream to allow more time for imprinting. • Reduce hatchery fry production. • Make recommendations to co-managers regarding increasing escapement to other sites.
Uncertainty No. 4—Will the hatchery produce adverse changes in chinook salmon populations?		
Operation of the broodstock collection facility does not significantly delay chinook migration or alter spawning distribution.	1. No significant delay or change in spawning distribution 2. Significant delay and change in spawning distribution*	• Modify operational protocols at the collection facility • Modify facility design.
There is no significant damage to incubating chinook eggs from sockeye superimposition on chinook redds or reduction in chinook reproductive success.	1. No significant damage or reduced reproductive success 2. Significant damage and reduced reproductive success*	• • Make recommendations to co-managers regarding lowering the escapement goal for sockeye. • Alter fry release strategy (spatial distribution).

Note: Potential response actions only address the undesirable outcomes, which are followed by an asterisk in the potential outcomes column.

TABLE 3-1 (continued).
SUMMARY OF AMP UNCERTAINTIES, HYPOTHESES, POTENTIAL RESEARCH OUTCOMES, AND MANAGEMENT ACTIONS

Hypothesis	Potential Outcomes	Potential Response Actions
Uncertainty No. 5—Will increased hatchery production alter aquatic community structure within the Lake Washington system?		
There is no relationship between sockeye abundance, growth and pre-smolt size in Lake Washington.	1. No relationship 2. Increased sockeye abundance and decreased growth and size* 3. Increased sockeye abundance and increased growth and size	• Examine temperature changes and effects to zooplankton. • Determine causal relationships. • Adjust hatchery production or release strategy if appropriate.
There is no relationship between sockeye abundance and the predation rates on salmonids in Lake Washington.	1. No relationship 2. Increased sockeye abundance and increased predation rate* 3. Increased sockeye abundance and decreased predation rate	• Determine causal relationships. • Adjust hatchery production if appropriate. • Adjust release strategy.
There is no relationship between sockeye abundance and the abundance of other planktivorous fish species.	1. No relationship 2. Increased sockeye abundance and decreased planktivore abundance* 3. Increased sockeye abundance and increased planktivore abundance	• Determine causal relationships. • Adjust hatchery production if there is a causal link with the hatchery and impacts are significant and adverse.

Note: Potential response actions only address the undesirable outcomes, which are followed by an asterisk in the potential outcomes column.

SECTION 4.
AMP MANAGEMENT

4.1 STRATEGY FOR SUCCESS

Section 2 of this document outlines a monitoring and research program considering the base of knowledge that exists and the major uncertainties thought to require careful future monitoring and evaluation. The technical program is expected to evolve each year based on its findings and information from ongoing efforts by the University of Washington, the Washington Department of Fish and Wildlife, the Muckleshoot Indian Tribe, and other investigators. Maximum benefit will be gained from the technical program by the following:

- Strategic use of monitoring resources so that the most important questions are addressed
- Having a well-managed and timely process to analyze the data and to store the results so that they are consistent, retrievable, and accessible to the public for scrutiny
- Establishing criteria for the statistical processes to be used with the various findings and thresholds of variation that can trigger modifications to hatchery operations
- Conducting an open, public process where technical recommendations are considered by the policy group and decisions made consistent with project objectives.
- Broad stakeholder involvement
- Involvement by credible and knowledgeable scientists
- Clear dispute resolution process
- Defined process for voicing minority opinion
- Emphasis on peer review in study plans, analysis and publication.

No matter how good the technical program is, a transparent, predictable and reliable process will be essential to convert the data into usable form and then into the appropriate operational decisions and actions.

There are many possible pitfalls at each step of the adaptive management process, including appropriate and adequate data collection, timely sample processing, analysis of study results, and adjustment of the hatchery program and AMP operations that incorporate the results of the study and its implications. The following steps are recommended to avoid these potential pitfalls:

- Sample and data analysis needs to be conducted in a timely manner. For example, large numbers of otoliths are currently collected in the field from adult and juvenile sockeye salmon. Experience indicates that considerable delay may occur between sample processing and the availability of the data. In order to make informed management

decisions, study results must be made available to managers within an acceptable time period. It is expected that project results, along with all study data, be made available within one year of data collection completion.

- The diverse data being collected by multiple investigators needs to be maintained in a database that is well organized and publicly available. Data compilation and management is an essential component of any large investigation. Archived data should include not only the primary data collected (such as redd counts), but the associated metadata as well. Metadata includes such things as the documentation of the study design: objectives, measurement methods, sampling design, and association of each primary data measurement with a time and place. The completeness and adequacy of the metadata are judged relative to the uses that might be contemplated for the analysis and interpretation of the primary data. Ancillary information that is necessary for re-analysis and interpretation of data is "necessary" metadata.
- Effective communication of the scientific findings to decision-makers will depend on having a designated scientific coordinator who will work with the technical work group to integrate and interpret research results and help the managers to translate results into the appropriate decisions (see Section 4.5 for a further discussion of this).

To ensure that program objectives are met, working group participants must act decisively on a scheduled basis to:

- Evaluate the data.
- Make information available to the public.
- Formulate any recommendations to modify hatchery operations.
- Consider and deliberate on these recommendations in a public forum.
- Adopt the changes necessary to meet program objectives.
- Implement those changes in the next cycle of operations.
- Monitor the results of the implemented actions to ensure that anticipated objectives are achieved.
- Periodically review monitoring program and adjust as necessary to address key issues

A proven model for successful adaptive management is for individuals with knowledge and commitment to the success of a program to work together in an open, transparent, agreed-upon structure. It has been shown in other communities that adaptive management of complex and controversial projects can be successful if the parties work together and reach agreement on support of management decisions. The management decisions need to be developed in a public process that has the benefit of comprehensive technical information and input from interested parties.

The evolution of fisheries science and management in the Pacific Northwest is rich in lessons learned from research and extensive fish culture and habitat management

programs that have had varying degrees of success. The Pacific Northwest is home to many of the world's leading experts in cold-water ecology, fish culture and fisheries management. The extent of the Cedar River Sockeye Hatchery's success will depend, in part, on the ability to enlist the proper expertise to deal with each major technical and management issue that arises.

Successful implementation will require commitment by those involved to initiate, maintain and evolve activities that serve the program's needs. In order to meet the proposed schedule for operating the hatchery in brood year 2007, the adaptive management process must be advanced soon enough to support the operating plan for that year. Suggested implementation steps are:

- Approve the Adaptive Management Plan in 2005 by the LMA parties
- Select a steering committee (by the LMA parties) to manage the AMP startup
- Select a steering committee chairman (by the LMA parties) who would later become operations manager for the Adaptive Management Work Group
- Develop a work plan that will ensure that necessary elements of the AMP, Hatchery Program Management and Annual Operating Plan are in place in time for the first year of operations. See Section 4.5 below for a proposed Implementation Schedule.

4.2 RELEVANT ORGANIZATIONS, COMMITTEES AND PANELS

4.2.1 City of Seattle

The City of Seattle has overall responsibility for implementing the HCP and is one of four parties to the LMA. It is responsible for management of impoundments and diversions of the Cedar River at Landsburg and upstream and for fisheries mitigation as defined in the HCP and LMA.

4.2.2 Washington Department of Fish & Wildlife

The Washington Department of Fish and Wildlife has responsibility for co-management of salmon runs in the Lake Washington Basin under provisions of federal court decisions. It has overall responsibility to preserve, protect and perpetuate the state's fish and wildlife. Within this broader duty of stewardship, the WDFW is to maximize fishing, hunting and outdoor recreational opportunities and to seek to maintain the economic well being and stability of the fisheries industry in Washington. The agency's authorities include establishing and enforcing regulations for time, place and manner of taking the state's component of harvestable salmon and for permitting and regulating in-stream activities.

4.2.3 Muckleshoot Tribe

The Muckleshoot tribe, together with the Suquamish and Tulalip tribes, has responsibility for co-management of salmon runs returning to the Lake Washington Basin under provisions of federal court decisions. These tribes' authorities include

establishing and enforcing regulations for time, place and manner of taking their component of the harvestable quota of salmon.

4.2.4 National Marine Fisheries Service

The National Marine Fisheries Service is responsible for the listing and protection of Pacific salmon species at risk under provisions of the Endangered Species Act. Its authorities include review and approval of state plans for recovery of listed species and "taking" under Sections 7 and 10 of the ESA.

4.2.5 U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service is responsible for listing and protection of most fresh water fishes, including salmonids, other than salmon that are at risk under provision of the Endangered Species Act. Its authorities include review and approval of state plans for recovery of listed species and actions involving "take" under Sections 7 and 10 of the ESA.

4.2.6 King County

King County is responsible for the protection of water quality and streamside riparian corridors under the provisions of the State Environmental Protection Act and the Shorelines Management Act. Its authorities include issuance of all building permits and special permits for any construction in sensitive areas and within shoreline zones in unincorporated regions of King County.

4.2.7 City of Renton

The City of Renton is responsible for protection of water quality and streamside riparian corridors under the provisions of the State Environmental Protection Act and the Shorelines Management Act. Its authorities include issuance of all building permits and special permits for any construction in sensitive areas and within shoreline zones within Renton City limits.

4.2.8 U.S. Army Corps of Engineers

The Army Corps of Engineers is responsible for regulating construction activities in wetlands and navigable waters under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899. Its authorities include issuance of permits for construction in wetlands and within navigable waters.

4.2.9 Washington State Department of Ecology

The Washington State Department of Ecology is Washington's principal environmental management agency. The Department administers a number of the state's environmental protection and resource management programs. Its authorities include environmental permitting under the Shoreline Management Act and overseeing water quality under various regulatory authorities.

4.2.10 The Cedar River Anadromous Fish Committee

The Cedar River Anadromous Fish Committee was established by the LMA and serves as an advisory group to the four parties to the agreement. This group has met monthly to review and discuss issues related to fisheries mitigation activities on the Cedar River. The AFC membership presently includes representatives from the following:

- The City of Seattle
- King County
- The Muckleshoot Tribe
- Washington Department of Fish & Wildlife
- National Marine Fisheries Service
- U.S. Fish and Wildlife
- Puget Sound Anglers
- Washington Trout
- Trout Unlimited
- Long Live the Kings
- Public at large.

4.2.11 The Science Panel

The science panel was assembled in early 2000 by invitation from the City of Seattle. Experts in sockeye biology, Lake Washington ecology, fish diseases, genetics and recent hatchery reform initiatives joined this panel from the University of Idaho, University of Washington, U.S. Fish and Wildlife Service, National Marine Fisheries Service and U.S. Geological Survey. They have provided guidance for the development of operating protocols and the monitoring program of the Cedar River Sockeye Hatchery.

4.3 MANAGEMENT PRINCIPLES

The following principles guide the design of the AMP organization and process:

- Monitoring and research programs need to be designed in response to the needs of management entities by scientists with qualifications and experience relevant to the Cedar River system issues.
- The design and results of monitoring and research programs should be independently reviewed by qualified peers.
- A workable process is required to communicate management needs to researchers, to develop recommendations based upon technical findings and to make and implement the appropriate decisions.
- A public forum is required for transfer of technical results to the management entities and to seek consensus on management response to technical findings.

- Interested parties should be provided access to available information as well as to the process for full and timely participation in proposals and recommendations.
- Consensus will be sought as biological results are evaluated and operating decisions are made.

4.4 AMP PARTICIPANT RELATIONSHIPS

One of the most important elements for a successful AM program is an appropriate management structure to implement the AM process correctly. Gold (2004) cited the following principles that should be considered in establishing a management structure.

- Maximize the collaborative process and public participation
- Provide parity between the needs of managers for information to support decision-making and the need for scientists to do the required monitoring and research
- Balancing the need for relevance with the need for quality and objectivity
- Having measurable goals and objectives
- Embracing uncertainty.

Figure 4-1 shows the proposed participants and their relationships for implementation and evolution of the AMP. Other participants in the process are the independent scientists, the researchers, the Technical Work Group and hatchery management. The primary path of communications runs between the Technical Work Group (TWG), the AMWG and the parties to the LMA. The public at large will have access to the information generated by the project as well as be able to participate in the decision-making process. This process is intended to be transparent in order to both serve the public's interest and provide the opportunity for productive input into management decisions.

4.4.1 Parties to the Landsburg Mitigation Agreement

The LMA states: "The Parties are committed to use adaptive management to address critical questions as they arise, and make changes in management based on the results of monitoring to meet the specific objectives of the program." In addition, the LMA states: "Except as otherwise provided, changes in all major aspects of study planning, implementation, and coordination with other related studies shall, within the indicated cost constraints, be subject to the approval of the Parties, in consultation with the [AFC] Committee,…". To be consistent with the LMA, the parties to the LMA will form the decision-making body that receives information and recommendations primarily through the AMWG. Party meetings will be open to the public and held as needed.

4.4.2 Adaptive Management Work Group

The AMWG, composed of agencies and stakeholders with an interest in the Cedar River Sockeye Hatchery Program, formulates recommendations to the parties. Under the LMA, the Cedar River AFC is designated to fulfill the role of the AMWG in providing advice to the parties on the operations and evaluation of the sockeye hatchery. Before the AMWG is formed, the parties will evaluate whether or not there is a need for change to the AFC to fulfill the role of the AMWG. This evaluation will include both the composition of the AFC and the ability of the AMWG to meet its goal of being representational, and discussion with the represented organizations to consider whether changes in individual representatives are needed to seat people best suited to the specific work of the AMWG. The SPU delegate will serve as chairperson and operations manager for the AMWG.

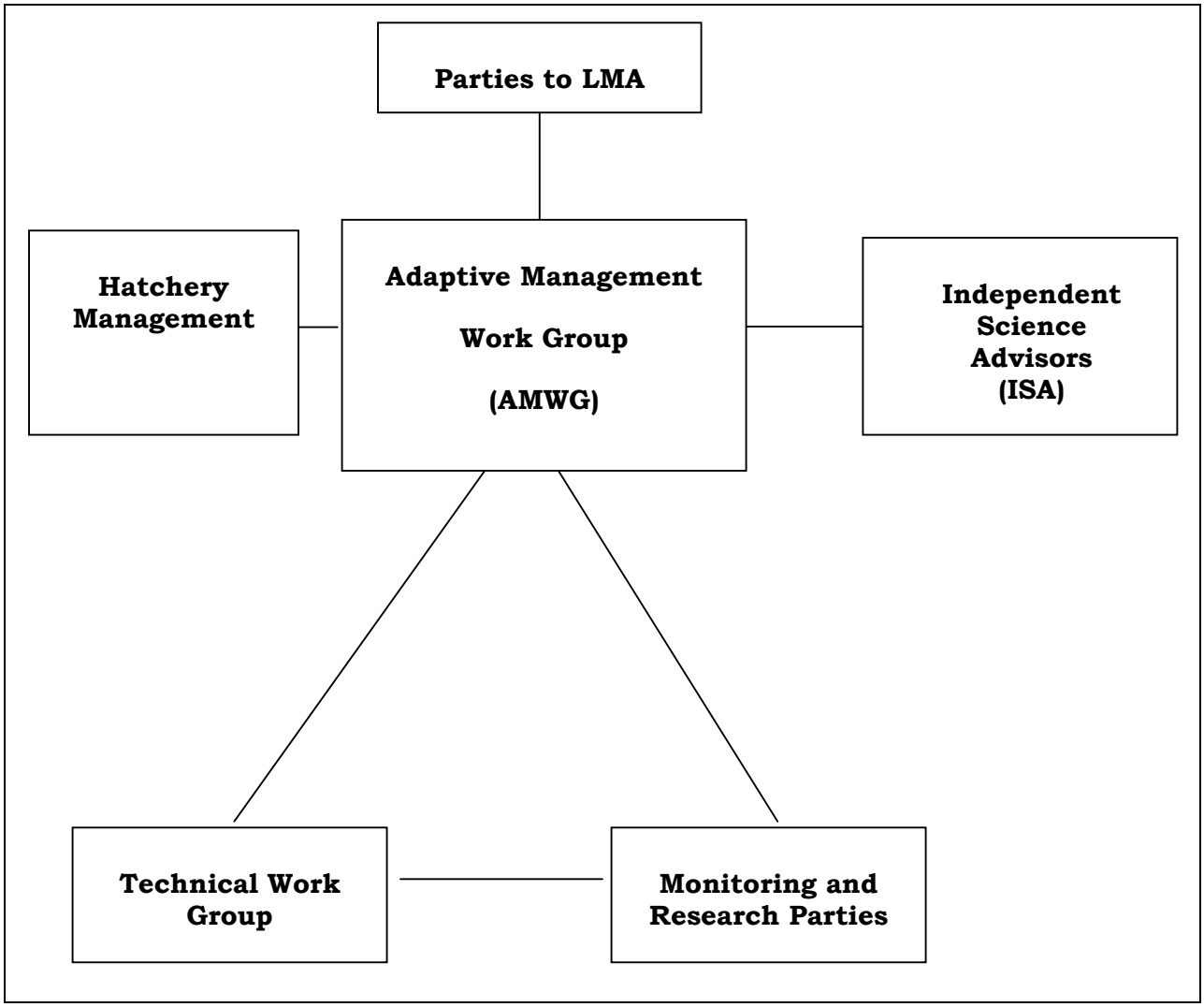


Figure 4-1. Proposed AMP Participant Relationships

The AMWG will be responsible for making recommendations to the parties regarding:

- The framework and detail for AMP policy, goals and direction.
- Membership of the Technical Work Group and the Independent Scientific Advisors
- Multiple-year budgets and annual operation plans within the context of a long-term (five-year) strategic plan.
- Final review and approval of all science and management activities
- Establishment of priorities for program implementation
- Adoption of a set of thresholds for each hypothesis in the AMP that will trigger the evaluation and decision-making process. A key component of the thresholds is the level of statistical certainty the monitoring program should be designed to achieve. The process of evaluating thresholds and for responding to threshold levels will encourage public involvement.
- Adoption of the annual report on current and projected year operations as described in the Operating Protocols.
- Oversight for hatchery operations for compliance with the operating plan with input from the technical work group, other scientific advisors and the public.
- Assembly and distribution of relevant technical information that comes available in between annual report cycles.

In addition, the AMWG will be responsible for the following:

- Assembly and distribution of relevant technical information that comes available in between annual report cycles
- Solicitation and coordination of input from all interested parties.

The AMWG will meet at least annually or as necessary to discuss reports from the Technical Work Group, hatchery managers and others concerning the hatchery program and its effects. These meetings will be public meetings to discuss hatchery activities and findings from the monitoring and research efforts. Meeting topics will generally be scheduled in advance, with agendas issued to the public two weeks in advance of the meetings.

Meetings will be conducted as working sessions where each topic is presented to the attendees by the operations manager or designee, with technical support coming from the ISA or the TWG, as needed. Initial discussions between all members of the AMWG will be conducted to clarify the details and for members to express opinions. This will be followed by any input from the public, and then by debate and the formation of any recommendations to the parties. If there is not consensus with the AMWG on a recommendation, then those holding the minority view shall be given the opportunity to prepare a written statement describing the justification for their position and this statement will be conveyed to the parties for consideration along with the majority's recommendation.

The AMWG operations manager will be responsible for maintaining regular communications with the co-managers, particularly with regard to run-size predictions and harvest management planning and regulating. The operations manager will also maintain regular contact with the parties, ISA, TWG and Hatchery Manager.

4.4.3 Technical Work Group

The TWG will be responsible for the use of sound science in the evaluation of the hatchery. This group will include at least minimum of five experts in the following areas: pathology, genetics, Lake Washington ecology, sockeye salmon biology and hatchery reform/operations. In addition to these five positions, it is recommended that two other at large positions be available if needed to provide for either appointment of a generalist or for other technical specialists that are identified. These appointees will be selected by the parties to the LMA in consultation with the AMWG. The TWG will elect a chair from its members. The City of Seattle will provide or arrange for technical support in the area of sampling design and statistical analysis, as needed.

It is proposed that the membership of the TWG be recruited from federal and state agencies, tribal organizations, universities, or private practice based primarily on the technical expertise needed and the commitment of candidates to sound resource stewardship. In addition to technical capability, potential members will be evaluated on their ability to work as part of a group and on their interest and ability to clearly communicate scientific information to managers and decision-makers. Members will be appointed on staggered terms. Candidates will not be chosen on the basis of representation of specific organizations or agencies.

Operating guidelines for the TWG will be approved by the parties before the TWG begins its work. The TWG will be responsible for the following:

- Reviewing and recommending the criteria and thresholds that would indicate the point at which either changes should be made to the hatchery program or formal evaluation should occur, as appropriate
- Drafting monitoring and research objectives, protocols and plans
- Developing and review budgets and RFPs for monitoring work
- Reviewing monitoring and research reports
- Overseeing data management and analysis
- Evaluating the effects of management actions
- Recommending the appropriate changes to hatchery operation when trigger points are reached.
- Recommending appropriate changes to the criteria and thresholds when appropriate.
- Recommending changes to the Annual Operating Plan.
- Providing technical review of the Annual Report on hatchery operations.

The TWG will meet on a quarterly schedule, or as necessary, to review new information that is accumulating from hatchery operations and the monitoring and research

activities, to conduct the business of the group to fulfill its responsibilities, and to finalize recommendations to the AMWG. These meetings will be open to the public.

A scientific coordinator will be selected by the parties to lead the TWG. The coordinator will chair meetings, plan the work of the TWG and represent the TWG before other committees and the parties. The scientific coordinator will be responsible for maintaining open communication links with the parties, the AMWG, hatchery management and the Independent Scientific Advisors. The TWG will provide advice as needed to ensure that the monitoring and research objectives are relevant, realistic and scientifically credible.

4.4.4 Independent Science Advisors

The Independent Science Advisors will serve as a review and recommending body of the AMWG and as an advisory body for the TWG and will make recommendations to resolve conflicts regarding technical, research, and management approaches. Advisors will be expected to provide independent assessments of monitoring data to determine if thresholds are exceeded, in cases where professional judgement is used as the primary basis for the decision. This group will be asked to do periodic program reviews. The results of any ISA review or any ISA recommendations will be given directly to the AMWG, TWG and the parties, with copies available to the public upon request.

A list of Independent Scientific Advisors will be developed that includes specialists in the Northwest, not serving on the TWG, who have the qualifications needed to review scientific and technical aspects of the AMP activities. Individuals such as college professors and scientists associated with state, federal or tribal organizations or in private practice are anticipated to form the pool of talent from which to recruit. Nominations for appointment to this group will be solicited from the stakeholder groups and public at large. The parties will select the names of the advisors, after soliciting advice from the AMWG.

4.4.5 Monitoring and Research Parties

Monitoring and research will be carried out by investigators in public agencies, universities or consulting firms who are qualified to perform the work required. These individuals will be involved in proposing ideas and methods to address key uncertainties and will be involved in implementing the studies, analyzing the data and reporting results to the TWG and others involved in the adaptive management process. The monitoring and research parties will be approved by the Parties to the LMA in consultation with the TWG and AMWG. Consideration will be given to technical expertise, experience, cost and other relevant factors in the selection of the Monitoring and Research Parties.

4.4.6 Hatchery Management

Hatchery management will be responsible for implementing the decisions of the parties regarding hatchery management operations and for operating the hatchery in an effective and efficient manner. Hatchery management will be overseen by the parties

and will interact with the AMWG and the TWG. This group has the following authorities:

- Implementation of technical, science, management or other activities approved and assigned by the parties in consultation with the AMWG
- Implementation of activities under its own authority, e.g., cost-saving management functions; improvement activities in technical/ management areas
- Make recommendations to changes in operations and policy management actions to the AMWG

4.4.7 Public Involvement

Public involvement plays a critical role in providing extended review of scientific findings and of recommendations made by the AMWG to the parties. Public involvement will be integrated throughout the AMP by providing access to information and recommendations, by providing opportunity to listen to committee deliberations and by providing opportunity to comment to committees.

4.5 AMP IMPLEMENTATION

Successful adaptive management is elusive. It is natural to get comfortable with routine and to resist change. Additionally, different pressures will come from various stakeholders to manage the hatchery to best suit their particular interests. It is essential that the policy/decision makers implement a rigorous program to start and evolve an AMP process that will achieve the stated goals and to do so in a manner that instills confidence in all stakeholders and the public at large that hatchery operations are conducted and modified based on the best scientific information available. Table 4-1 provides a proposed series of the major steps foreseen to get the AMP up and running in concert with the start up of first year hatchery operations.

TABLE 4-1.
ADAPTIVE MANAGEMENT PLAN IMPLEMENTATION

Activity	Date
Final drafts of Adaptive Management Plan (AMP), Capacity Analysis, and Operating Protocols Submitted to Anadromous Fish Committee for recommendation	~~May~~ August 2005
Parties to the Landsburg Mitigation Agreement Decision	~~June~~ September 2005
Parties to the Landsburg Mitigation Agreement approve membership and operating guidelines for Technical Working Group (TWG) and Adaptive Management Work Group (AMWG)	June 2006
Monitoring and Research Parties (MRP)/ TWG / ISA/ AMWG review Adaptive Management Plan and Operating Protocols and refine / modify criteria and thresholds.	July 2006- January 2007
Development of data management and monitoring protocols (TWG, ISA, AMWG, Parties)	January 2007
Establish Data Management System	March 2007

TWG reviews annual report on hatchery program and provides comments to AMWG	Annually beginning in 2007
TWG recommends priorities for Adaptive Management by reviewing existing uncertainties and hypotheses and adjusting as needed to provide direction for the monitoring program.	Annually beginning in 2007
TWG reviews and recommends modifications, if needed, to criteria, thresholds, and responses	Annually beginning in 2007
Annual operating plan submitted by TWG to AMWG for review and Party approval	Annually beginning in 2007
Review monitoring protocols	Every 5 years

4.6 DATA ACQUISITION AND MANAGEMENT SYSTEM

The development of a system to ensure that the appropriate information is collected, reviewed and stored is crucial to enabling the objective evaluation of the program. The data management system will include procedures for the acquisition, transfer, QA/QC, archival and access to data. Standards will be developed for metadata and data storage. This work will be done during the year before the hatchery begins operation.

4.7 DISPUTE RESOLUTION PROCESS

The goal of the adaptive management committees will be to reach consensus in recommendations and decisions. When this is not possible at the committee level, provisions for the expression of minority opinions will be made so that decision-makers and the public are informed of the diversity of views. When the parties disagree, the dispute resolution process will follow that described in the LMA.

4.8 PROCESS FOR RESPONDING WHEN THRESHOLDS ARE EXCEEDED

The Adaptive Management Plan establishes thresholds (Section 2) that are used to define in advance what would constitute unusual and undesirable outcomes associated with key uncertainties. These thresholds are defined for each set of hypotheses and are intended to be reviewed during the period prior to implementation and periodically thereafter as information is gathered to ensure that they are set appropriately. Where feasible to do so, statistical testing will be used to determine if thresholds have been exceeded. In other cases, experts will be asked to use statistical and quantitative analyses to aid their determination of whether results are significant. In the latter situation, both the TWG and the ISA would be asked to provide their independent assessments of the data to the Parties. If the Parties conclude that a threshold has been exceeded, the parties will ask the TWG to determine the cause. The TWG would be expected to consult with any of the researchers involved and may consult with Independent Scientists as well. The Parties may decide to ask for an independent assessment of cause by independent scientists. The TWG and the independent scientists (when involved) will provide their findings to the AMWG, along with any actions that they recommend be taken. The AMWG will consider the TWG findings and recommendations, along with any from independent scientists, and develop their recommendation for consideration to the parties. The parties will meet to review reports, hear from the public and decide how to respond to the

recommendations. If the parties do not accept the recommendations of the AMWG, the parties must provide reasons for doing so and these shall be provided to the public and committees upon request. If response actions are required, monitoring will continue to determine whether the response action has been successful in reducing the effect so that it drops below the threshold level. If the response action is unsuccessful, further analysis would lead to consideration of alternatives. Thus, the adaptive management process is a cycle involving monitoring, evaluation, adjustments to operations, when necessary, and continued monitoring and evaluation (see Fig. 1-1). For further information see Section 2 and 3.

4.9 SUMMARY

The long-term success of the Cedar River Sockeye Salmon Hatchery hinges upon effective cooperation and coordination between the involved agencies, the Muckleshoot Tribe, the stakeholders, the public and the scientific community. This hatchery is very significant because of its visibility, history, and potential benefit. An extraordinary level of effort is being invested in implementing this sockeye mitigation project in a manner that is compatible with natural systems. There is a risk that complicated procedures could result in excessive costs and reduced benefits. To optimize the scientific and other community benefits, it is incumbent upon all participants to streamline and simplify where possible while striving to meet project objectives.

The Adaptive Management Plan and the other program documents are proposed to become the basis for the Annual Operating Plan for the first year of operations and for the management structure that will be necessary for implementation of a successful Adaptive Management process. Discussions and negotiations between the participants will be needed to finalize the roles and responsibilities of each participant and to select the proper team. Membership in the technical groups and hatchery management should always be based upon technical expertise and professionalism, not on affiliation. Early initiation of discussions between the parties and their advisors should lead to an effective startup and hopefully good operating efficiency and more healthy fish in the Lake Washington system.

SECTION 5.
LITERATURE CITED

Ames, J. and H. Beecher. 2001. Incorporating flood risk into controlled spawning flow regimes for Pacific salmon: an example using Cedar River sockeye salmon. Washington Department of Fish and Wildlife Report #FPT 01-13. Olympia, WA. 123 p.

Bams, R.A. 1967. Differences in performance of naturally and artificially propagated sockeye salmon migrant fry, as measured with swimming and predation tests. Journal of the Fisheries Research Board of Canada 24: 1117-1153.

Bentzen, P. and I. Spies. 2000. Investigation of genetic variability within and between Lake Washington sockeye salmon populations using microsatellite markers. Unpublished report submitted to City of Seattle. 20 p.

Brannon, E.L., D.A. Beauchamp, D.E. Campton, C.V.W. Mahnken, and J.R. Winton. 2001. The Cedar River Sockeye Salmon Hatchery Plan. Special Scientific Advisory Panel to the City of Seattle. 55 p.

Burgner, R. L. 1987. Factors influencing age and growth of juvenile sockeye salmon (*Oncorhynchus nerka*) in lakes, p. 129-142. In: Canadian Special Publication of Fisheries and Aquatic Sciences 96. H. D. Smith, L. Margolis, and C. C. Woods (eds.).

Burgner, R.L. 1991. Life history of sockeye salmon (*Oncorhynchus nerka*). In C. Groot and L. Margolis (eds.). Pacific salmon life histories. UBC Press. Vancouver, British Columbia. pp. 1-117.

Burton, K., S. Foley and W. Mavros. 2001. Cedar River chinook salmon (*Oncorhynchus tshawytscha*) redd survey report, 2000: Spawning habitat characteristics, spatial and temporal redd distributions, and the incidence of spawning sockeye in the vicinity of incubating chinook. Report published by Seattle Public Utilities. 43 pp.

Burton, K., L. Lowe and Berge, H. 2004. Cedar River chinook salmon (*Oncorhynchus tshawytscha*) redd and carcass surveys: annual report 2003.

Carvalho, G. R., T. J. Pitcher, L. K. Park, P. Morgan, R. D. Ward, P. M. Grewe, G. R. Carvalho, L. Hauser, M. Ferguson, F. M. Utter, J. M. Wright, P. Bentzen, and R. Lincoln. 1994. Molecular genetics in fisheries. Reviews in Fish Biology and Fisheries. 4:269-399.

Cascade Environmental Services, Inc. 1995. Cedar River Fall Chinook and Sockeye Salmon Run Timing. Presented to the Cedar River Instream Flow Committee.

Chilcote, M. W., S. A. Leider, and J. J. Loch. 1986. Differential reproductive success of hatchery and wild summer-run steelhead under natural conditions. Transactions of the American Fisheries Society. 115:726-735.

DeVries, P. 1997. Riverine salmonid egg burial depths: review of published data and implications for scour studies. Canadian Journal of Fisheries and Aquatic Sciences. 54:1685-1698.

Essington, T. E., P. W. Sorensen, and D. G. Paron. 1998. High rate of redd superimposition by brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) in a Minnesota stream cannot be explained by habitat availability alone. Canadian Journal of Fisheries and Aquatic Sciences. 55:2310-2316.

Essington, T.E., T.P. Quinn and V.E. Ewert. 2000. Intra- and interspecific competition and the reproductive success of sympatric Pacific salmon. Canadian Journal of Fisheries and Aquatic Sciences 57: 205-213.

Fresh, K.L., S.L. Schroder, E.C. Volk, and J.J. Grimm. 2001. Straying by Cedar River hatchery-produced sockeye salmon to Big Bear Creek, WA. Washington Department of Fish and Wildlife, Olympia, WA. 9 p.

Fresh, K. L., S. L. Schroder, E.C. Volk, J.J. Grimm and M.C. Mizell. 2003 Evaluation of the Cedar River sockeye salmon hatchery: analyses of adult otolith recoveries. Washington Department of Fish and Wildlife, Olympia WA. 42 p.

Gold, Barry. 2004. Review of the March 2003 Adaptive Management Plan, Cedar River Sockeye Hatchery.11p.

Halbert, C.L. 1993. How adaptive is adaptive management? Implementing adaptive management in Washington State and British Columbia. Reviews in Fisheries Science 1 (3): 261-283.

Henderson, M. A., and A. J. Cass. 1991. Effect of smolt size on smolt-to-adult survival for Chilko Lake sockeye salmon (*Oncorhynchus nerka*). Canadian Journal of Fisheries and Aquatic Sciences. 48:988-994.

Hendry, A.P., O.K. Berg and T.P. Quinn. 1999. Breeding date, life history, and energy allocation in a population of sockeye salmon (*Oncorhynchus nerka*). Oikos 85: 499-514.

Hendry, A.P. and T.P. Quinn. 1997. Variation in adult life history and morphology among Lake Washington sockeye salmon (*Oncorhynchus nerka*) populations, in relation to habitat features and ancestral affinities. Canadian Journal of Fisheries and Aquatic Sciences 54: 75-84.

Hendry, A.P., T.P. Quinn and F.M. Utter. 1996. Genetic evidence for the persistence and divergence of native and introduced populations of sockeye salmon (*Oncorhynchus nerka*) within Lake Washington, WA. Canadian Journal of Fisheries and Aquatic Sciences 53: 823-832.

Hendry, A. P., J. K. Wenburg, P. Bentzen E. C. Volk and T. P. Quinn. 2000. Rapid evolution of reproductive isolation in the wild: evidence from introduced salmon. Science 290: 516-518.

Holling, C.S. (ed.). 1978. Adaptive Environmental Assessment and Management. John Wiley & Son. New York.

Koenings, J.P. and R.D. Burkett. 1987. Population characteristics of sockeye salmon (*Oncorhynchus nerka*) smolts relative to temperature regimes, euphotic volume, fry density, and forage base within Alaskan lakes. Pp. 216-234. In: Canadian Special Publication of Fisheries and Aquatic Sciences 96. H. D. Smith, L. Margolis, and C. C. Woods (eds.).

Koenings, J. P., H. J. Geiger, and J. J. Hasbrouck. 1993. Smolt-to-adult survival patterns of sockeye salmon (*Oncorhynchus nerka*): effects of smolt length and geographic latitude when entering the sea. Canadian Journal of Fisheries and Aquatic Sciences. 50:600-611.

Lee, K.N. 1999. Appraising adaptive management. Conservation Ecology 3 (2): 3 [online] URL: http://www.consecol.org/vol3/iss2/art3.

Leider, S. A., P. L. Hulett, J. J. Loch, and M. W. Chilcote. 1990. Electrophoretic comparison of the reproductive success of naturally spawning transplanted and wild steelhead trout through the returning adult stage. Aquaculture. 88: 239-252.

Nowak, G. M., R. A. Tabor, E. J. Warner, K. L. Fresh and T. P. Quinn. 2004. Ontogenetic shifts in habitat and diet of cutthroat trout in Lake Washington, Washington. North American Journal of Fisheries Management 24: 624-635

Perrin, C. J., and J. R. Irvine. 1990. A review of survey life estimates as they apply to the area-under-the-curve method for estimating the spawning escapement of Pacific salmon. Canadian Technical Report of Fisheries and Aquatic Sciences. 1733:1-49.

Quinn, T.P. 1993. A review of homing and straying of wild and hatchery-produced salmon. Fisheries Research 18: 29-44.

Quinn, T.P., A.P. Hendry and L.A. Wetzel. 1995. The influence of life history trade-offs and the size of incubation gravels on egg size variation in sockeye salmon (*Oncorhynchus nerka*). Oikos 74: 425-438.

Roni, P. 1992. Life history and spawning habitat in four stocks of large-bodied chinook salmon (*Oncorhynchus tshawytscha*). Master of Science thesis, University of Washington, Seattle. 93 p.

Ryman, N. 1991. Conservation genetics considerations in fishery management. Journal of Fish Biology. 39:211-224.

Schroder, S. 2005. Results of otolith decodes performed on sockeye smolts collected in Lake Union in May 2004. Memorandum to Anadromous Fish Committee, Washington Department of Fish and Wildlife, March 2, 2005. 10 p.

Seiler, D. 1994. Cedar River sockeye salmon fry estimation, Final Report: June 1994. Washington Department of Fish and Wildlife. Olympia, WA.

Seiler, D. 1995. Annual Report: Estimation of 1994 Cedar River sockeye salmon fry production. Washington Department of Fish and Wildlife. Olympia, WA.

Seiler, D. and L. Kishimoto. 1996. Annual Report: 1995 Cedar River sockeye salmon fry production evaluation program. Washington Department of Fish and Wildlife. Olympia, WA.

Seiler, D. and L. Kishimoto. 1997a. Annual Report: 1996 Cedar River sockeye salmon fry production evaluation. Washington Department of Fish and Wildlife. Olympia, WA.

Seiler, D. and L. Kishimoto. 1997b. Annual Report: 1997 Cedar River sockeye salmon fry production evaluation. Washington Department of Fish and Wildlife. Olympia, WA.

Seiler, D., G. Volkhardt and L. Kishimoto. 2001. 1999 Cedar River Sockeye Salmon Fry Production Evaluation. Washington Department of Fish and Wildlife, Report #FPA 01-14.

Seiler, D., G. Volkhardt and L. Fleischer. 2005A. Evaluation of Downstream Migrant Salmon Production in 2003 from the Cedar River and Bear Creek. Report FPT 05-01, Washington Department of Fish and Wildlife, Olympia WA. 69 p.

Seiler, D., G. Volkhardt and L. Fleischer. 2005B. Evaluation of Downstream Migrant Salmon Production in 2004 from the Cedar River and Bear Creek. Report FPT FPT 05-05. Washington Department of Fish and Wildlife, Olympia WA. 65 p.

Spies, I., K. Naish and P. Bentzen. 2001. Microsatellite analysis of current and source populations of sockeye salmon and kokanee (*Oncorhynchus nerka*) in the Lake Washington basin of Washington state. Unpublished report to City of Seattle. 26 p.

Steen, R.P. and T.P. Quinn. 1999. Egg burial depth by sockeye salmon (*Oncorhynchus nerka*): implications for survival of embryos and natural selection on female body size. Canadian Journal of Zoology 77: 836-841.

Walters, C.J. (ed.). 1986. Adaptive Management of Renewable Resources. Macmillian. New York.

Waples, R. S. 1991. Genetic interactions between hatchery and wild salmonids: lessons from the Pacific Northwest. Canadian Journal of Fisheries and Aquatic Sciences. 48 (Supplement 1): 124-133.

Washington Department of Fish and Wildlife. 2001. Operational Guidelines for the Cedar River Weir and Fish Trap, 2001 Field Season. Olympia, WA. 3 p.

Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1992. 1992 Washington State Salmon and Steelhead Stock Inventory. Olympia, WA. 212 p.

Washington, P.M. and A.M. Koziol. 1993. Overview of the interactions and environmental impacts of hatchery practices on natural and artificial stocks of salmonids. Fisheries Research 18: 105-122.

Young, S.F., M.R. Downen and J.B. Shaklee. 2001. A Microsatellite DNA Based Characterization of Lake Washington/Lake Sammamish Kokanee and Sockeye Salmon, With Notes on Distribution, Timing, and Morphology. Washington Department of Fish and Wildlife, Olympia, WA.

Appendix B – Workshop Summaries

WORKSHOP PARTICIPANTS

Worst Case Analysis Workshop Summary: Genetics Issues

Craig Busack, Washington Department of Fish and Wildlife
Donald Campton, U.S. Fish and Wildlife Service
Jon Drake, Northwest Fisheries Science Center, National Marine Fisheries Service
Thomas Quinn, University of Washington
Reginald Reisenbichler, Biological Resources Division, U.S. Geological Survey
Steven Schroder, Washington Department of Fish and Wildlife

Worst Case Analysis Workshop: Predation

David Beauchamp, University of Washington, USGS
Dave Seiler, Washington Department of Fish and Wildlife
Roger Tabor, U.S. Fish and Wildlife Service
Jonathon Frodge, King County
Daniel Schindler, University of Washington
Kurt Fresh, National Oceanic Atmospheric Association Fisheries Service

Worst Case Analysis Workshop – Superimposition

Ernie Brannon, Chair, Professor, University of Idaho
Tim Essington, Professor, University of Washington
Steve Foley, Biologist, Washington Department of Fish and Wildlife
Dave Seiler, Biologist, Washington Department of Fish and Wildlife

Worst Case Analysis Workshop Summary: Genetics Issues

Thomas P. Quinn
School of Aquatic and Fishery Sciences
University of Washington

Introduction

A series of three workshops were held simultaneously on April 29, 2004, to allow selected experts to discuss possible "worst case" scenarios pertinent to the expansion and modification of the Cedar River sockeye salmon hatchery. This draft document reviews the deliberations of the group asked to consider three specific issues related to the genetics of sockeye salmon in this population and others within the Lake Washington drainage: straying of hatchery-produced salmon into other breeding populations elsewhere in the basin to the detriment of those populations, homogenization of sockeye salmon populations within the Cedar River system itself to their detriment, and domestication selection (a process that might occur within the Cedar River hatchery but that would reduce the fitness of sockeye salmon for reproduction in the river).

Participants

The genetics session was moderated by Mr. Martin Baker (City of Seattle), and the participants were as follows (in alphabetical order):

Dr. Craig Busack, Washington Department of Fish and Wildlife
Dr. Donald Campton, U.S. Fish and Wildlife Service
Mr. Jon Drake, Northwest Fisheries Science Center, National Marine Fisheries Service
Dr. Thomas Quinn, University of Washington
Dr. Reginald Reisenbichler, Biological Resources Division, U.S. Geological Survey
Dr. Steven Schroder, Washington Department of Fish and Wildlife

Approach

The session began with a brief general introduction to the three main issues that had been identified for us as the focus of our efforts: straying, homogenization, and domestication. This was designed to provide background for participants about the genetics-related concerns that had been expressed regarding the hatchery. We then briefly discussed another genetics issue, changes in genotype resulting from low effective population size. This is a concern in many conservation situations because it can result in rapid reductions in fitness and genetic drift. However, the numbers of salmon in the Cedar River are so large that this was dismissed by the group without argument and not discussed further. Following this introduction, the group discussed the three issues in that order. After the three issues had been discussed, Mr. Baker described the forms that we were to use for quantifying the risk assessment. There were comments and points of clarification, after which we filled out the forms individually (i.e., without consultation within the group). Then, following the same order (straying, homogenization, and domestication), we each presented our risk assessments and explained the assumptions and logic behind the conclusions. After everyone had presented his views on each issue, we reconvened with the entire group, heard summaries from the chairs of the groups

examining the other two issues (ecological interactions, and redd superimposition), and our findings were summarized by Dr. Quinn. We were then thanked for our services, details regarding follow-up activities were provided, and we departed.

This report is an attempt to summarize the discussion that was held by these people, on this date. Many ideas were brought up more than once, and the discussions often followed non-linear paths. Therefore, this is not a verbatim record or a transcript. Rather, it is an effort to provide an accurate and comprehensible report on what was said. The report does not identify the specific individuals that made remarks, and lists the risk assessments anonymously. This was at the request of several members of the group, for two reasons. First, the views of the group as a whole are most important rather than those of specific individuals. If comments were attributed to individuals, readers might infer too much from the differences of opinion. Second, the scientists were using their technical expertise as the basis for their views but were not speaking on behalf of their agencies, some of which have expressed official opinions regarding the hatchery. The views expressed at the meeting were not authorized as representative of agency policy, so it seems more proper not to attribute comments to individuals. However, the individuals are listed by letter (A to F) in the attachments, and the text refers to these individuals by letter to provide some sense of the variation in views among individuals within the group.

Straying among Lake Washington spawning populations

As discussed by the group, the essential issue with regard to straying is that the Lake Washington basin presently consists of sockeye salmon breeding in discrete locations other than the Cedar River (e.g., Bear Creek, Issaquah Creek, and beaches in the lake itself). The sockeye breeding at these sites differ in phenotypic traits (e.g., timing of breeding, age composition) that have probably evolved as a result of natural selection, and at least some of them differ in genotype, indicating reproductive isolation. The group was willing to accept the assumption that the differences in life history traits among populations contribute to their fitness.

The term fitness has many definitions and there were discussions by the group of what it means, and what is the most relevant way to measure it. Those discussions took place with respect to all the hypothesized genetic effects (i.e., straying, homogenization, and domestication) but for brevity the discussion is only summarized here. We agreed that a functional definition of fitness is the ability of naturally spawning fish to produce offspring that survive to successfully reproduce. Thus a reduction in fitness is a reduction in reproductive success by individuals or types of individuals (e.g., Bear Creek sockeye). We understand that many factors affect the production of offspring by salmon, including climate related factors such as flooding during incubation, temperature during lake residence, and oceanographic factors affecting survival at sea. In addition, there are density-dependent factors such as competition for spawning sites and disturbance of nests. However, our concept of fitness from a genetic standpoint was independent of these factors. That is, if we controlled for environmental change (e.g., climate) and density, would there be a reduction in the reproductive success of salmon of a given type in their natal stream? In the case of straying, the concern was that interbreeding by Cedar River sockeye with those from the other populations (e.g., Bear Creek) might be expected to reduce the fitness of the Bear Creek fish. Specific experiments demonstrating such reduction in fitness have not been conducted for these populations but this assumption is based on sound principles.

This reduction in fitness does not specifically depend on changes in the Cedar River population that might arise from the hatchery (though those might exacerbate the matter). Rather, the basic concern is that the Cedar River fish are presumably better adapted for the Cedar River than they are for Bear Creek, and so by breeding in Bear Creek or by interbreeding with Bear Creek fish they would reduce the average fitness of fish in Bear Creek. To the extent that the Cedar River hatchery resulted in reductions in fitness with respect to the Cedar River, these might further decrease the fitness of the fish for breeding in Bear Creek. However, the analysis by the group did not hinge on these possible future conditions.

Sockeye salmon generally display a high degree of homing and differentiation of populations, and the present differences in traits among populations imply that whatever level of straying currently exists has not homogenized them. The hatchery might increase the number of strays into other breeding sites by one of two mechanisms. First, even if the proportion of sockeye salmon straying from the Cedar River into the other populations stays the same (i.e., straying is density-independent), the increased numbers of Cedar River sockeye salmon would increase the number of strays. Second, it is possible that the hatchery-produced sockeye salmon might have a greater tendency to stray than naturally produced Cedar River sockeye salmon.

Bear Creek

A key element in the group's deliberations was a report by Fresh et al. (2001). These scientists examined otoliths from 1,219 Bear Creek sockeye salmon from 1998, 1999, and 2000 and did not find a single fish with the distinctive marking patterns that identify hatchery fish with a high degree of accuracy. The marking technique and ability to detect marks is not in question, so the parsimonious conclusion is that Cedar River hatchery fish comprised a very small proportion of the spawners in Bear Creek in those years. The true (underlying) level of straying was discussed, because there might have been a few strays that were missed by chance so the true level of straying may not be 0%. Indeed, the group assumed that the true level of straying was greater than 0% but agreed that the number was probably on the order of 1% or less (two scientists regarded it as <0.5%). The group acknowledged that some level of straying takes place under fully natural conditions, and that the existence of a few strays from the Cedar River into the Bear Creek population does not constitute a problem p*er se*. The group concluded (see quantitative analysis below) that under current hatchery practices (releases of fry at or shortly after emergence into the Cedar River itself) there will inevitably be some very low level of straying into Bear Creek (and, by extension, other small creeks at the north end of the lake). The only reasons for uncertainty surrounded the extent to which these practices will be continued. The group felt that releases into the lake itself would be likely to increase straying, perhaps markedly.

The consequences of straying were assessed in terms of fitness, and genetic diversity. We first considered the likelihood that the fitness (i.e., productivity) of the Bear Creek population will be reduced by straying from the Cedar River. We tried to determine the central tendency in the evaluations by the six responding scientists. The most obvious way to do this is by taking the average value (sum divided by the number of respondents) in each of the 10 levels of effect (0 – 10%, 10 – 20%, etc.). However, the median may be a more representative way to characterize the central tendency, because the values are not normally distributed. The median represents the value in the middle if an odd number of values are arranged in rank order, and the average of the two middle values if there is an even number. The attached tables show the average (i.e., mean)

and median values but in the text we will refer to the medians. One should note that the median values do not necessarily add up to 100%, unlike the sum of average values. The median values indicated a 95% chance of a 0-10% reduction in fitness from straying, and a 5% chance of a 10-20% reduction (Attachment 1). In one case a finer degree of assessment was recorded in marginal notes on the tally sheets. Scientist B estimated a 70% probability of no impact at all and a 30% chance of an impact ranging from 1-5%.

The six estimates were skewed, however, and depended on the assumptions made. Five of the six scientists felt that there was at least a 90% chance that the effect would be 0-10%, and some specified even lower probabilities. The only scientist expressing a greater level of concern (Scientist C) made the assumptions that there was no Adaptive Management Plan and that the straying rate from the Cedar River would increase to 5-10% of the population within 5-10 generations. Most scientists made the assumptions that the hatchery would produce up to its planned capacity (ca. 34 million fry) and that the fry would be released into the river. Only one scientist explicitly estimated possible increases in straying resulting from different release strategies so these values could not be averaged. Scientist E explicitly noted that, "If current protocols and assumptions are violated, as is likely due to human nature, then probabilities will be shifted to the right; i.e., expected impacts increase substantially."

There was some discussion of the validity of the assumption that the fry would be released in the river. Some level of mortality seems to occur in the river as the fry are migrating down to the lake, and it seems to be a function of distance and conditions when the fish are released. It might be natural for staff at the hatchery to try to improve the survival of the fry by releasing them as close to the lake as possible, and at some point in the future they might negotiate for permission to release them in the lake itself. However, there is documentation that the distribution of adult sockeye throughout the Cedar River depends on releasing them as fry throughout the river, and the group felt that the necessity of releasing fry in the river was sufficiently established that they were willing to assume that this practice will not change. Scientist F explicitly considered the straying risk under the assumption of releases into the lake as well as the assumption of river releases, and he concluded that the difference was slight (if all fry are released in the river: 97% chance of 0-10% effect and 3% chance of 10-20% effect; if >50% of the fry are released into the lake: 93% chance of 0-10% effect and 7% chance of 10-20% effect). Scientist C took the most precautionary position, assuming (as a worse case) that there would be no adaptive management process and that all fry would be released into the lower Cedar River or the mouth of the river. He assumed that the natural selection favoring homing would be reduced and straying would increase markedly above current levels. He therefore projected substantially higher levels of risk than any of the other six scientists.

In addition to the assessment of the probability that the fitness (reproductive success) of the Bear Creek (and, by extension, other tributary populations) would be affected by straying from the Cedar River, we also noted that such straying might affect the genetic makeup of the "recipient" population in other ways. Maintaining all the genetic diversity of a population is not necessarily a prerequisite for success, and the stability of gene frequencies over time is not essential for persistence. However, the capacity of a population to adapt to new challenges (e.g., temperature, disease, etc.) in the future may depend on some level of diversity. This can be quantitatively measured using selectively neutral markers. The assumptions made by the scientists for this

measure of effect were similar to those made for a loss in fitness. Five of the six scientists assessed the level of change in allele frequencies (or a related measure) that might be expected to occur. The median values of these responses indicated a 90% chance of a 0-10% change, an 8% chance of a 10-20% change, and a 5% chance of a 20-30% change (Attachment 2). These were not intended to mean that equivalent reductions in fitness would occur. Indeed, there is no unequivocal link between measures of genetic variation (e.g., Fst) and quantified measures of fitness such as number of offspring and it is not clear whether, how, or when these changes might affect the fitness of the population.

The higher levels of change anticipated in this measure, compared to fitness (see above), result from the fact that these genetic changes are assumed to be more neutral to selection and so might occur more quickly. That is, the combinations of alleles at different microsatellite loci, for example, do not seem to enhance fitness, and so would be affected by straying more rapidly than traits experiencing selection. It is possible that in some future set of circumstances there may be benefits associated with these genotypes or with genetic traits that are linked to them but this is speculative.

The group recognized that both of these measures of effect (change in realized reproductive success, and change in gene frequencies) are flawed so they are recommended in concert. The first is subject to statistical "type-II error." This is the probability that a true effect will be undetected because of high variation, a small number of independent samples, a small intrinsic effect, or a combination of these factors. In the case of straying into Bear Creek (or, in subsequent analyses, effects within the Cedar River itself) the measurement would be a reduction in the expected number of fry produced per spawner. The expected level of fry production would have to be adjusted for the density of adults and for environmental conditions, especially winter flooding. In this case, each year only contributes one independent data point. The errors in counting adults and fry would combine with the natural variation around the true relationships between density, flow, and fry production to make it difficult to detect any but the most dramatic reductions in fitness. This measurement was chosen over the presence of stray Cedar River hatchery fish in the Bear Creek populations because their presence alone would not constitute an impact (though without stray fish no effect could occur, so there is value in such information). We recognized that the ability to detect a decrease in productivity of the Bear Creek population from strays is weak. Neither is the other measurement, related to the frequency distribution of selectively neutral genetic markers, ideal. It does not by itself really indicate a change that reduces the present ability of the population to persist.

Lake Washington beaches

The group not only considered the issue of straying from the Cedar River into Bear Creek but also straying into the beach spawning populations in the lake itself. These spawning grounds, notably one located at Pleasure Point, are geographically much closer to the Cedar River than Bear Creek is to the Cedar River, and the beach populations are much less numerous at present than those in Bear Creek. These facts both make the beach populations much more susceptible to straying from the Cedar River than is the Bear Creek population. Some level of straying apparently goes on from the Cedar River into the Pleasure Point beach population, yet the beach population displays small but significant differences from the Cedar River in both life history traits and gene frequencies (based on papers by Quinn et al. 1999 and Hendry et al. 2000). The

scientists generally felt that the reduction in fitness in the beach populations associated with stray Cedar River fish would be greater than was projected for the Bear Creek population. Specifically, five of the six scientists completed risk assessment forms and the medians of their estimates were a 50% chance of a 0-10% reduction in fitness, a 30% chance of a 10-20% reduction, and a 20% chance of a 20-30% reduction (Attachment 1). These assessments were based on assumptions that were similar to those made by each person with respect to the Bear Creek straying issue: 34 million fry, released in the Cedar River with little or no rearing at the hatchery.

It should be noted that the estimates of the effects of straying on the beach population were much less consistent among the scientists than were the estimates for effects on Bear Creek (see Attachment 1). In fact, there was some uncertainly as to whether straying to the beach population was even an issue for discussion. Three scientists filled out forms during the meeting, and two supplied assessments later upon request. In a memo dated May 20, the other scientist stated:

> "In the absence of additional data, I would consider ANY straying from the Cedar River (hatchery-origin or natural-origin) to largely be inconsequential UNLESS there was a specific management plan in place to develop a genetically-distinct beach spawning population. Such a plan would have to establish adult escapement goals for natural spawning and identify specific geographic areas where spawning occurs (or would occur). To my knowledge, such [a] plan has not been developed."

There was some discussion of the fact that the beach population(s) may be at risk of extinction from factors unrelated to the hatchery (e.g., shoreline habitat modification) and may also be at risk from hatchery-related processes other than genetics (notably fishing pressure). However, these ideas were not explicitly integrated into the finding with respect to genetics. The issue of fisheries is also relevant to the future status of the Bear Creek population but the genetics group did not quantify or discuss this matter. As with the Bear Creek population, we considered the possible loss in adaptive potential (measured by the diversity of selectively neutral traits) in this population that might result from straying. It was felt that this process would be more likely to occur and that the reductions would probably be greater than were projected for Bear Creek. The median estimated reductions were: 35% chance of a 0-10% reduction, 20% chance of a 10-20% reduction, 14% chance of a 20-30% reduction, 6% chance of a 30-40% reduction, 3% chance of a 40-50% reduction, and a 1% chance of a 50-60% reduction (Attachment 2). As with the estimates for loss of fitness, there was much less agreement among the scientists regarding the effects of straying on gene frequency in the beach population than the Bear Creek population.

Straying – general conclusions

The level of concern about straying from the Cedar River hatchery into tributary populations in the basin was low. The lack of concern stemmed mainly from (1) the empirical evidence from WDFW research indicating an exceedingly low occurrence of strays into Bear Creek (undetectable in 1,219 fish examined); (2) the geographical isolation of the Cedar River from the other main spawning sites; (3) a sense that straying by sockeye salmon is generally rare; (4) a sense that a low level of straying occurs naturally and probably causes little or no harm.

However, the level of concern was greater for the beach spawning populations than the Bear Creek population. By and large these conclusions were based on the assumptions that the hatchery would produce its capacity of 34 million fry but that they would be released in the river after little if any rearing.

Homogenization of population structure within the Cedar River

Just as straying from the Cedar River hatchery into other spawning grounds in the Lake Washington basin could tend to reduce the adaptive variation in those populations to their detriment, it is also possible that present or evolving population structure within the Cedar River might be reduced or eliminated by the operation of the hatchery. This "homogenization" of populations was the second aspect of genetics that was discussed by the group. We considered two processes by which this might occur. First, the adult sockeye salmon trapped at the weir will include fish destined for all spawning areas above that point. The present plans call for the weir be located near the mouth of the Cedar River. So, if there were populations in tributaries of the Cedar River with unique attributes that enhance their fitness, some of these fish would be gathered for spawning at the hatchery in proportion to their abundance. They would be mated randomly with other fish, mostly from the Cedar River, and so any unique attributes would tend to become lost through homogenization. In addition, it is possible that there are spawning groups within the Cedar River itself (e.g., upper reaches of the river) with distinct attributes that would be lost by similar homogenization in the hatchery.

The second process by which the Cedar River population complex might become homogenized stems from release patterns. Evidence collected by WDFW indicated that fry released in the upper, middle, and lower reaches of the river had a significant (but far from absolute) tendency to return as adults to those regions. To the extent that this occurs, naturally produced adults that would ordinarily have returned to the upper reach, for example, might not only be spawned with fish from a tributary, but their offspring might be released into the lower river, further disrupting the population structure.

There is evidence that the sockeye salmon spawning in the Cedar River system co-vary in spatial and temporal distributions. Specifically, the upper reaches of the river seem to be used before the lower reaches, and some of the off-channel spawning sites are used late in the season. The highest counts of adults in the mainstem Cedar River are generally from late September through late November, whereas counts in Wetland 79 tend to peak in late November and early December, and those in Cavanaugh Pond are highest in December and January. Scientist B pointed out that the fish are not held long in the hatchery, so the early maturing fish will continue to be mated with other early maturing fish, and the temporal structure in the population will tend to be retained. Indeed, the spawning season in the river is so protracted (September through December or even later) relative to the instream lifespan of any individual that some degree of genetic separation between the ends of the distribution is not surprising.

After identifying the processes by which homogenization might occur, the group's discussion centered around the extent to which the Cedar River system might presently contain distinct subpopulations. The evidence regarding present population structure seems to be mixed and equivocal. The entire population was the result of transplants that began in the 1930s (the most

likely source of the present population is Baker Lake, in the Skagit River system), and this recent origin might argue against complex population structure.

On the other hand, the early returning sockeye seem to spawn predominately in the upper reaches whereas the later fish tend to spawn in the lower reaches (though considerable overlap takes place). This kind of spatial/temporal structure is seen in some other wild salmon populations, and it suggests that some level of homing and adaptation may be evolving or have already evolved. There are also spawning sites in tributaries and side channels, both natural and man-made. In some cases these spawning groups display distinct (often late) timing. This may result from difficulty in accessing the site earlier in the season, or it may reflect the inherent traits of the fish. However, some degree of colonization clearly occurs because the spawning channel at Ron Regis Park was occupied at high density in the first season it was open, and those adults could not possibly have been spawned there. The group then considered the question of what fraction of the sockeye salmon in the Cedar River system spawn in side channels, tributaries, and other sites outside the mainstem of the river. No one present had precise numbers so the group assumed that the figure would be on the order of 5-10% of the spawning taking place in these alternative habitats. The numerical dominance of the mainstem Cedar River population means that even a small proportion of strays from the Cedar River (as might be expected under normal circumstances unrelated to a hatchery) would reduce the tendency for local adaptations to evolve in tributaries and side channels.

The group recognized that the evolution of adaptive traits in salmon populations is a natural process but it is unclear to what extent this process has already occurred in the Cedar River system, and the extent to which it will occur in the future, even in the absence of a hatchery. The experimental releases of marked hatchery fry did not show complete fidelity to the release sites as adults, so a considerable amount of genetic exchange probably goes on within the river system. However, salmon run timing and spawn timing exhibit some heritability, and the total spawning period is much longer than the instream lifespan of individual salmon, so some degree of genetic separation between early and late breeding fish is likely to occur. There were comments on the existing genetics work (notably that of Ingrid Spies and Paul Bentzen from the University of Washington). These data indicated reduced gene flow between early and late breeders but the samples were not collected in space and time in a manner that would fully resolve the issue. In addition, as with the issue of straying between spawning sites (e.g., Cedar River and Bear Creek), the importance of differences at selectively neutral loci is not clear.

The subsequent discussion centered around the assessment of fitness effects on the Cedar River population complex, elaborating on ideas raised in the discussion of straying. Indeed, it was pointed out that there are some parallels between the issue of straying (homogenization of sockeye salmon in the Lake Washington basin) and homogenization of subpopulations with the Cedar River. However, the processes causing the changes differ; those in the Cedar River itself are more directly linked to the hatchery operations. It was concluded that the only really convincing evidence of harm would be a decrease in the number of fry produced by naturally spawning females in the Cedar River system. As mentioned in the section on straying, such an assessment depends on several types of data and analyses: accurate counts of the number and sex ratio of naturally spawning adults, accurate counts of the number of naturally produced fry, statistically sound relationships between adult density and fry production, and between

environmental factors (chiefly winter flow) and fry production. In the case of the Cedar River system, the fry enumeration that has been conducted by the Washington Department of Fish and Wildlife was viewed as quite accurate, given the large size of the population. The discussions by the group were based on the assumption that this enumeration program would continue at the same level of accuracy. If it does not continue or becomes markedly less accurate, then a reduction in the fitness (i.e., reproductive success) of naturally reproducing sockeye salmon would not be detectable. The adult counts are somewhat more problematical. There was some discussion of the fact that they hinge on both counts of the number of salmon in the river on a series of dates and on estimates of the instream lifespan of individual adult sockeye salmon. There is error in both of these parts of the equation for estimating the total population.

Errors in estimating the total number of spawning adult sockeye salmon and their offspring are combined with variation in the strengths of the relationships between *per capita* fry production and density, and river flow. These relationships have been established (i.e., the number of fry produced per female is lower when the density of adults is high, and lower when river flows are high, than when density and flows are low). The null hypothesis would be that the form of this relationship would not change over time. If hatchery practices were limiting the adaptive diversity of populations in the river system, then the predicted alternative would be that the *per capita* fry production, adjusted for density and flow experienced in that year, would decline.

In general, the group agreed that the numerical parent-offspring relationship is an essential way to evaluate possible changes in fitness in the population complex. However, we recognized that the method has weaknesses. As discussed in the section above on straying, failure to detect a change does not mean that no change has taken place, and so only very large changes are likely to be detected. In addition, the degradation of fitness that might occur would be gradual, not step-like, and such a progressive change might be masked by other subtle, time-varying processes operating in the river. For example, habitat restoration projects might tend to increase the productivity of the river for wild fry, and so might mask declines in genetic fitness. On the other hand, habitat degradation might reduce fry productivity, creating the appearance of a decline in fitness where none in fact took place. Another drawback of this assessment approach is that it does not consider the upward evolutionary trajectory of the population that might be expected to occur in the absence of a hatchery. One might expect, given the fact that the population is less than 70 years old, that it is still evolving toward a suite of locally adapted phenotypic traits. Homogenization by the hatchery might retard or halt such evolution, effectively freezing the process of differentiation that might otherwise occur. Finally, most of the estimates of fry production have taken place during the years of the hatchery's operation. There were four years of fry counts conducted by the Washington Department of Fish and Wildlife in brood years before hatchery-produced adults returned to spawn. Data were collected by Dr. Quentin Stober (University of Washington) but for four other years, and with a somewhat different method than that used in the recent years.

Given these reservations about relying solely on a "parent to fry production relationship," the group elaborated on discussions held earlier (in the context of straying) regarding the need for maintaining the "adaptive potential" of the population. Future conditions such as climate, new pathogens, competitors, and other biotic and abiotic factors may affect the population in ways that it has not been challenged to date. The ability to respond to these challenges rather than

slide toward extinction may depend on genetic traits whose present value is not obvious. The retention of genetic diversity may increase the likelihood that the population can successfully meet such challenges in the future. It was recognized that there is no perfect way to measure this adaptive potential, but a convenient and useful surrogate is the level of genetic diversity as quantified by selectively neutral genetic markers. This can be indexed by the Fst value but the group did not settle on a specific way to measure diversity; it was agreed that some such measurement would be an important counterpart to the assessment of reproductive success. Realized reproductive success (fry per adult) best approximates what we are most concerned about but is somewhat insensitive, whereas genetic diversity may be measurable with more precision but is at most indirectly linked to the problems that might occur in the future.

Quantified Risk Assessment

All six members of the group filled out forms that quantified the level of reduction in fitness anticipated to occur over a 50-year period as a consequence of homogenization in the Cedar River system. The averages of these estimates were as follows: a 60% chance of a 0-10% reduction, a 31% chance of a 10-20% reduction, and a 10% chance of a 20-30% reduction. There was some variation among individuals in the anticipated impact, and the assumptions upon which the estimate was made. Scientist D projected the lowest level of reduction (80% chance of a 0-10% reduction), under the assumptions that the weir collecting adults would be located in the lower part of the river and that there would be a "disconnect between adult collection date and fry release site," including the possibility that all hatchery fry would be released from the lower river. Scientist B projected a 70% chance of a 0-10% reduction in fitness. He assumed that any existing population structure is weak and has "low biological significance" but noted that there is "major uncertainty [regarding] whether true genetic structuring exists." Scientist A also projected a 70% chance of a 0-10% reduction in fitness, under the assumption that the "hatchery operation is conducted as planned, especially in terms of release site." Scientist E projected a 50% chance of a 0-10% reduction and a 41% chance of a 10-20% reduction, under the assumption that "some population structure exists that bestows real fitness benefits and would continue to develop in the absence of a hatchery program." Scientist C projected a higher level of reduction in fitness than these three scientists (70% chance of a 10-20% reduction), and he assumed (among other things) that "population structure currently exists along spatial and temporal patterns" and that there are "co-adapted loci with strong heritability." Scientist F projected a slightly higher level of reduction than Scientist C (80% chance of a 10-20% reduction), and wrote, "I believe the up-river population will retain its genetic integrity but low and middle sections are likely to be impacted. If the majority of the releases occur in the lower river then recruitment to the upper portion may decrease over time."

Five of the six members of the group filled out forms that quantified the level of reduction in genetic diversity anticipated to occur as a consequence of homogenization in the Cedar River system. The medians indicated a 10% chance of a 0-10% reduction, a 15% chance of a 10-20% reduction, and a 10% chance of a 20-30% reduction. The distribution of estimates among the scientists was so skewed that these medians are difficult to interpret. The averages of their values were not much more consistent: a 21% chance of a 0-10% reduction, a 27% chance of a 10-20% reduction, a 16% chance of a 20-30% reduction, a 6% chance of a 30-40% reduction, a 4% chance of reductions from 40-50%, 50-60%, and 60-70%, a 15% chance of a 70-80%

reduction, a 3% chance of a 80-90% reduction, and a 1% chance of a 90-100% reduction (Attachment 2).

The variation among the five scientists (Scientist B did not fill out a form) in the estimated level of reduction was extreme for this issue, to the extent that the neither the median nor the average of the values is very representative. Scientist D estimated the lowest level of effect, an 80% chance of 0-10% reduction, under the assumption that there is probably little if any existing structure but that the hatchery operation is highly likely to have a small effect. Scientist F projected the next lowest level of effect (10% chance of a 0-10% reduction, 80% chance of a 10-20% reduction, and 10% chance of a 20-30% reduction). However, his notes indicated he regarded it as highly likely (80-90% probability) that homogenization of the populations would occur over 12 generations (about 50 years). Thus his estimate of the effect (80% chance of a 10-20% reduction) was a reduction in allelic frequency. Scientist C made the assumption that "population structure currently exists along spatial and temporal patterns" and his estimates of the likely loss of "adaptive capacity" were greater than Scientist F's. Scientist E indicated a high degree of uncertainly about the level of change, recording probabilities from 0-10% all the way to 80-90% (Attachment 2). Scientist A felt that any measurement of genetic diversity among possible subpopulations within the Cedar River would decrease 70-80% as a result of hatchery operations, but because the level of genetic differentiation can be expected to be quite low, this would have very little impact on the population as a whole in terms of fitness loss.

Summary of Homogenization Effect

Discussions of the possible effects of the hatchery on existing or future genetic population structure within the Cedar River system reflected uncertainty as to whether any such structure exists and whether it has any biological significance. However, to adopt a "worst case scenario," the group made the assumption that such structure exists and indeed has a positive influence on the fitness of sockeye salmon in the river system. It was further assumed that hatchery practices (collection of adults, breeding, and distribution of fry) would indeed tend to homogenize the population. Given these assumptions, the group felt that there is a real chance of a reduction in fitness (averaged as a 90% chance that the reduction would be between 0 and 20% and a 10% chance that it would be 20-30%; Attachment 1). The group was unanimous in estimating that the most likely level of reduction would be between 0 and 20% (that is, no higher level was considered very likely). However, much more uncertainty was reflected in the assessment of the likely reduction in genetic diversity. There was really no consensus within the group as to this effect.

Domestication

The third major issue under discussion by the group was the process of domestication. As with the other topics, our approach was to discuss the subject first, then consider how to measure the effects, and then conduct individual assessments of risk. The fundamental concern is that sockeye salmon taken for breeding in the hatchery will be exposed to selective forces that differ from those operating on salmon in the Cedar River system, and (most importantly) that these forms of selection will reduce the ability of their offspring to successfully reproduce in the river when they return.

Domestication selection was recognized as a genetic process by which animals in culture evolve differences from their wild parents or ancestors. This is distinguished from differences between wild and cultured animals (e.g., salmon in hatcheries) that result from learning (e.g., feeding near the surface) or environmental induction (e.g., differences in size or growth rate). The selection that causes these genetic differences can be direct and deliberate or indirect and inadvertent. For example, some hatcheries deliberately select early arriving fish for breeding, and this can result in a rapid change in the average date of return and maturation by the population. It is clear from a variety of documents that the people designing the Cedar River sockeye salmon hatchery and its oversight committees are determined to avoid this phenomenon and other forms of direct selection for traits in the hatchery. Therefore, the group operated under the assumption that the forms of selection that might result in domestication would be largely indirect and inadvertent.

Inadvertent domestication selection seems to operate primarily at two phases in the life history of salmonids, adult and juvenile, and most research has been conducted on the latter phase. Experimental evidence indicates that behavior patterns such as predator avoidance and aggression are under partial genetic control, and the regimes of selection operating on a hatchery population will differ from those operating on a wild population. These differences may contribute to the differences in productivity of wild and hatchery fish breeding under natural conditions. The extent to which these processes operate probably depends on the extent to which the juvenile fish are reared under artificial conditions. The longer they are held, the more likely it is that such selection will occur. The Cedar River hatchery is designed to minimize the period of juvenile rearing prior to release, and so the process of domestication selection on juveniles is likely to be very slight. However, to the extent that the rearing is protracted, this concern increases.

In addition to forms of domestication selection operating on juveniles, there are inescapable processes related to breeding in the hatchery. When salmon return from the ocean to breed, the sexes have well-defined roles in the reproductive process that are innate, as there has been no opportunity for learning or practice. Females choose suitable nesting sites based on criteria such as water depth, velocity, size of the substrate, areas of upwelling groundwater, and other physical traits. Choice of a poor site can reduce the survival of embryos, so natural selection is constantly culling individuals from the population that make poor choices. Females that would have made poor choices are indistinguishable by humans from those that would have made good choices, so a hatchery in effect relaxes selection on the ability to choose a good nest site. In addition to the choice of a nesting site, there are other behavior patterns by females that affect reproductive success. The female must compete with other females for the best sites, dig a series of egg pockets and determine when each is ready for egg deposition, choose among the available mates, complete spawning, bury the fertilized eggs, and defend the redd vigorously. None of these behavior patterns occur in a hatchery and no human can discern which females would be most adept at these essential skills.

Likewise, male salmon differ in traits associated with sexual selection, including size of the teeth, length of the jaws, body depth, color, and aggression. These traits are involved in male competition and female choice, and they may signal that the male possesses traits that are of fundamental importance such as the ability to forage successfully at sea. The combined processes of choice and competition between the sexes result in a complex breeding system that

has been described by a variety of studies using behavioral observations and genetic parentage analysis. Hatchery staff may employ a specific breeding scheme regarding how many males and females have their gametes mixed together, and how fish are selected for breeding, but no scheme can perfectly mimic the processes that would occur in a wild population.

There does not seem to be any study that has teased apart the processes of domestication selection during adult and juvenile phases of the salmon life history that would specifically allow us to project the rate at which these processes would occur and their effects on the fitness of sockeye salmon under a hatchery regime such as is planned for the Cedar River. Indeed, to our knowledge no study has been conducted demonstrating genetic differences between wild and hatchery populations of sockeye salmon that would be directly comparable for either phase.

We reviewed models that have been created to estimate the roles of four important processes in domestication selection: (1) the intensity of the domestication selection, (2) the length of time that the fish are held in the hatchery (i.e., juvenile residence time), (3) the rates of gene flow between the wild and hatchery populations and the proportion of fish in the combined population that are bred in the hatchery, and (4) the length of time (in generations) that the hatchery operates. Two complementary models of domestication were discussed. The first was that of Lynch and O'Hely (2001), who considered domestication to be the product of two phenomena: (1) relaxation of selection in the hatchery of characteristics selected against in the wild, and (2) selection for characteristics in the hatchery that are selected against in the wild (antagonistic selection). Depending on the degree of relaxation assumed, a substantial genetic load due to relaxation can build up, even over the expected 50-year duration of the Cedar River hatchery operation. For discussion of antagonistic selection another model was introduced, that of Ford (2002). This model has been used extensively by the Hatchery Scientific Review Group (2003) in developing hatchery guidelines. This model demonstrates that the equilibrium value of a trait will be between the optimal values of hatchery and natural populations. The exact value of the equilibrium trait will depend on the ratio of the proportion of natural-origin fish incorporated into the hatchery broodstock each year, and the proportion of hatchery-origin fish on the spawning grounds. It can be shown using the Ford model that the equilibrium trait value will be intermediate between the two optima if these two gene flow levels are equal. The equilibrium value will be closer to the natural optimum if the proportion of natural-origin fish in the broodstock exceeds the proportion of hatchery-origin fish on the spawning grounds. Controlling these gene flow rates is problematic. In the Cedar River program, where the intent is for both natural spawners and hatchery broodstock to have the same natural-origin:hatchery-origin composition, keeping equilibrium trait values closer to the natural optimum requires that hatchery-origin fish make up less than 50% of the run. The perception of the risk of domestication by the workshop participants was strongly influenced by their perception of the proportion of hatchery-origin fish among the spawning adult salmon in the future.

Having considered the processes by which domestication selection might occur, and the virtual impossibility of preventing it, the group considered how its effects might be measured. This discussion was closely linked with the discussions held earlier regarding straying and homogenization of populations. Specifically, the group concluded that the important trait is the number of offspring produced by naturally spawning fish in the system. This would be measured

in the same manner as the homogenization of Cedar River subpopulations, and would be subject to the same kinds of technical and statistical problems.

Because the ratio of wild and hatchery-origin fish in the composite population is a very important part of the models (and something that can be accurately measured), there was considerable discussion of the "worst case scenario" in this aspect of the sockeye salmon population. The group was aware of the possibility that the vagaries of survival might occasionally result in ratios skewed toward hatchery-origin fish, and also that humans might feel pressure to increase the production from the hatchery if the abundance of wild fish declined. However, the quantified estimates of the level of change that might be expected in the population were based on the assumption that the hatchery protocols (a running average of no more than 50% of the adults returning to spawn being of hatchery origin).

Quantified Risk Assessment

The assessment of risk in terms of reduced reproductive success of naturally spawning sockeye salmon over a 50-year period was similar to that related to the possible homogenization of the population. The medians of the values reported by the six scientists were a 65% chance of a 0-10% reduction, a 29% chance of a 10-20% reduction, and a 3% chance of a 20-30% reduction. The assumptions underlying these assessments were generally that the hatchery would operate as planned, producing 34 million fry. Scientist B, for example, listed as assumptions that the "number of natural-origin adults returning to the Cedar River will be greater than the number of hatchery-origin adults" and that "domestication will only affect those traits associated with reproduction, egg incubation, and fry emergence." Scientist A likewise assumed that the "hatchery operates as planned, especially in terms of rearing time." However, Scientist F assumed that there would be a mix of unfed and fed fry, and he noted that "the more prolonged the rearing period the greater the effect," and Scientist D assumed that "fry rearing [will be] limited to 2 weeks."

Summary of Domestication

The scientists agreed that this is an issue where some change in the regimes of selection is likely if not inevitable, especially regarding adult traits associated with reproduction. The extent to which the selection regimes affecting juveniles will change will depend on how the hatchery is operated. The environment for embryo development and emergence will differ from a natural one. Prolonged rearing in the hatchery would be likely to affect the fitness of the population but it was assumed that this would not take place. The difficulty lies not in determining that the selection regimes will change but in estimating how much these changes will actually affect the fitness of the population. Definitive, relevant studies on the subject have not been conducted and so the group made its interpretations on the basis of models, general knowledge of salmonid biology and genetics, and the patchwork of studies on the subject. We concluded that there was a high probability that the reduction in fitness would be between 0 and 20%, under plausible worse case scenarios.

Additional Considerations

Any interpretation of the deliberations of the group should bear in mind several things. First, the process of quantifying risk assessments depends strongly on what is assumed in terms of both underlying biology and future human behavior. In this case, the scientists were not given a uniform set of assumptions for each topic. They were free to make their own assumptions, and so the risk analysis might have had different results if other things had been assumed. Second, there was some degree of arbitrariness in the levels of risk, and the assessments were made on the spur of the moment by each individual.

In addition to considerations about how the assessments were made, it is important to remember that the topics were considered one at a time rather than in concert with each other. It is unclear how the combined effects of population structure, homogenization, and domestication selection might operate. We did not discuss such interactions among effects, so it is not reasonable for those reading this report to assume that the effects would be additive, compensatory, or make any other assumptions about their interactions. In the same vein, we did not specifically address interactions between genetics effects on the populations and the effects of other processes such as fisheries, competition for food in the lake, or changing environmental conditions. We caution readers against drawing any conclusions based on combinations of this report and other risk assessment reports.

References Cited

Ford, M.J. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. *Conservation Biology* 16(3):815-825.

Fresh, K.L., S.L. Schroder, E.C. Volk, and J.J. Grimm. 2001. *Straying by Cedar River Hatchery-Produced Sockeye Salmon to Big Bear Creek, WA.* Report by Washington Department of Fish and Wildlife to the Cedar River Sockeye Salmon Technical Committee.

Hendry, A.P., J.K. Wenburg, P. Bentzen, E.C. Volk, and T.P. Quinn. 2000. Rapid evolution of reproductive isolation in the wild: Evidence from introduced salmon. *Science* 290: 516-518.

Hatchery Scientific Review Group (HSRG). 2003. *Management Goals for Hatchery Broodstocks: Genetic Integration versus Segregation.* Report available at www.hatcheryreform.com.

Lynch, M., and M. O'Hely. 2001. Captive breeding and the genetic fitness of natural populations. *Conservation Genetics* 2:363-378.

Quinn, T.P., E.C. Volk, and A.P. Hendry. 1999. Natural otolith microstructure patterns reveal precise homing to natal incubation sites by sockeye salmon (*Oncorhynchus nerka*). *Canadian Journal of Zoology* 77: 766-775.

Attachment 1. Levels of reduction in reproductive success predicted to occur under plausible worst case scenarios associated with the Cedar River sockeye salmon hatchery, as recorded on the basis of discussions on April 29, 2004.

Topic	Scientist	Levels of Impact									
		0 – 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60	60 - 70	70 - 80	80 - 90	90 - 100
Domestication selection	A	80	15	5	0	0	0	0	0	0	0
	B	90	10	0	0	0	0	0	0	0	0
	C	20	80	0	0	0	0	0	0	0	0
	D	85	15	0	0	0	0	0	0	0	0
	E	49	42	9	0	0	0	0	0	0	0
	F	10	80	10	0	0	0	0	0	0	0
	average	56	40	4	0	0	0	0	0	0	0
	median	65	29	3	0	0	0	0	0	0	0
Homogenization	A	70	20	10	0	0	0	0	0	0	0
	B	70	15	15	0	0	0	0	0	0	0
	C	20	70	10	0	0	0	0	0	0	0
	D	80	15	5	0	0	0	0	0	0	0
	E	50	41	9	0	0	0	0	0	0	0
	F	10	80	10	0	0	0	0	0	0	0
	average	50	40	10	0	0	0	0	0	0	0
	median	60	31	10	0	0	0	0	0	0	0
Straying to beaches	A	90	5	5	0	0	0	0	0	0	0
	B*										
	C	50	30	20	0	0	0	0	0	0	0
	D	10	30	30	20	10	0	0	0	0	0
	E	5	45	45	5	0	0	0	0	0	0
	F	65	32	3	0	0	0	0	0	0	0
	average	44.0	28.4	20.6	5.0	2.0	0	0	0	0	0
	median	50	30	20	0	0	0	0	0	0	0

Topic	Scientist	Levels of Impact									
		0 – 10	**10 - 20**	**20 - 30**	**30 - 40**	**40 - 50**	**50 - 60**	**60 - 70**	**70 - 80**	**80 - 90**	**90 - 100**
Straying to Bear Creek	A	90	5	3	2	0	0	0	0	0	0
	B	100	0	0	0	0	0	0	0	0	0
	C	40	40	20	0	0	0	0	0	0	0
	D	95	5	0	0	0	0	0	0	0	0
	E	95	5	0	0	0	0	0	0	0	0
	F	97	3	0	0	0	0	0	0	0	0
	average	86	10	4	0	0	0	0	0	0	0
	median	95	5	0	0	0	0	0	0	0	0

* This scientist did not provide a prediction for this topic.

Attachment 2. Levels of reduction in genetic diversity or change in allele distribution predicted to occur under plausible worst case scenarios associated with the Cedar River sockeye salmon hatchery, as recorded on the basis of discussions on April 29, 2004.

		Levels of Impact									
Topic	**Scientist**	**0 -10**	**10 - 20**	**20 - 30**	**30 - 40**	**40 - 50**	**50 - 60**	**60 to 70**	**70 - 80**	**80 - 90**	**90 - 100**
Homogenization	A	0	0	0	0	0	5	10	70	10	5
	B*										
	C	10	30	50	10	0	0	0	0	0	0
	D	80	15	5	0	0	0	0	0	0	0
	E	5	8	16	21	20	13	8	5	4	0
	F	10	80	10	0	0	0	0	0	0	0
	average	21	26.6	16.2	6.2	4	3.6	3.6	15	2.8	1
	median	10	15	10	0	0	0	0	0	0	
Straying to beaches	A	90	10	0	0	0	0	0	0	0	0
	B*										
	C	60	20	20	0	0	0	0	0	0	0
	D	10	20	30	25	10	5	0	0	0	0
	E*										
	F	7.5	85	7.5	0	0	0	0	0	0	0
	average	41.9	33.8	14.4	6.3	2.5	1.3	0	0	0	0
	median	35	20	13.75	0	0	0	0	0	0	
Straying to Bear Creek	A	90	5	5	0	0	0	0	0	0	0
	B*										
	C	20	50	20	10	0	0	0	0	0	0
	D	80	15	5	0	0	0	0	0	0	0
	E	92	8	0	0	0	0	0	0	0	0
	F	97	3	0	0	0	0	0	0	0	0
	average	75.8	16.2	6	2	0	0	0	0	0	0
	median	90	8	5	0	0	0	0	0	0	0

* This scientist did not provide a prediction for this topic.

Supplemental Evaluation: Estimates of Straying to Bear Creek

Dr. Thomas Quinn

Some level of straying is expected in salmon populations. However, evidence indicates that the rates of straying by hatchery-produced fish from the Cedar River to Bear Creek (and by extension, other tributaries at the north end of the lake) are very low. WDFW examined otoliths from 1,219 Bear Creek sockeye salmon from 1998, 1999, and 2000 and did not find a single fish with the distinctive marking patterns that would have identified it as a hatchery fish from the Cedar River (Fresh et al., 2001). The marking technique and ability to detect marks are not in question, so the conclusion is that Cedar River hatchery fish must have composed, at most, a very small proportion of the spawners in Bear Creek in those years. The workshop participants felt that a few strays may have been missed by chance, so the true level of straying from the Cedar River to Bear Creek was not assumed to be zero for worst case conditions, but it is probably on the order of 1% or less.

The Cedar River produces about 10 times as many adult sockeye salmon as does Bear Creek. Thus if 1% of the Cedar River sockeye strayed, they would constitute on the order of 10% of the sockeye in Bear Creek. If the Cedar River population grew even larger as a consequence of the hatchery, even this small percentage of strays from the Cedar River might constitute enough strays entering the Bear Creek subpopulation to pose some risk. After the workshop concluded, I conducted a more extensive evaluation, based on WDFW data provided by Steve Foley to SPU including counts of adult salmon in the Cedar River and Bear Creek. I attempted to refine the estimate of the straying rate of sockeye salmon from the Cedar River into Bear Creek, rather than assuming the 1% figure is correct.

I considered the question, "If over 1,000 adult salmon were examined in Bear Creek and no hatchery-marked fish were found, how large might the true fraction of marked fish have been?" For example, if the true fraction of marked fish were 10%, then one would expect to find 100 marked fish in a sample of 1,000. However, by chance one might find 90 or 110, or even 80 or 120 marked fish. Therefore, how likely is it that one might find zero marked fish in a sample of 1,000, given the true fraction of 10%?

My analysis indicated that if the true number of marked fish in Bear Creek was 4 or more in the sample of 1,219 examined by WDFW, then it is likely (based on tables of statistical probabilities and accepting a 5% chance of being wrong) that at least one marked fish would have been found. I therefore concluded that the true fraction of marked fish in Bear Creek could have been no more than 0.003, or 0.3%. I then attempted to estimate what this number might translate to as a percentage of the Cedar River run in those years. This was complicated by the fact that not all Cedar River fish were marked (i.e., some were wild). There are good estimates of the proportion of marked fry, but if the hatchery fish survive at lower rates than the wild fish, those numbers would tend to minimize the apparent straying rate. To be conservative (i.e., tend to err on the side of overestimating the magnitude of straying from the Cedar River, hence overestimating the magnitude of the problem), I assumed that the survival rate of hatchery fry was only 0.4 times that of wild fry. This assumption was used to estimate the number of marked salmon that might have been present in Bear Creek at different levels of hypothesized straying. These figures lead

to the estimate that, averaged over the three years of samples (1998, 1999, and 2000), the maximum rate of straying from the Cedar River into Bear Creek was 0.21% of the Cedar River population. Higher levels of straying would be inconsistent with the absence of marked fish detected in the samples examined by WDFW. The actual level of straying was probably less than 0.21%, but for purposes of subsequent analysis a figure of 0.2% is used.

Worst Case Analysis Workshop:
Predation-Competition Report

Group Topics.
1. Competition with other species or stocks for food supply in Lake Washington
2. Predation

Participants (Panel Members)
Dave Beauchamp (UW-USGS)
Dave Seiler (WDFW)
Roger Tabor (USFWS)
Jonathon Frodge (KC)
Daniel Schindler (UW)
Kurt Fresh (NOAA Fisheries)

Facilitator
Sarah McKearnan

Recorder
Paul Faulds

Observers
Bruce Bachen (SPU)
Michael Kern (LLK)
Molly Adolfson (SEPA Consultant)
Judith Noble (SPU SEIS Manager)

Approach for the Competition and Predation Analysis

Topics addressed during workshop
The ecological concerns focused on how the proposed sockeye salmon hatchery might affect predation and competition effects on juvenile sockeye or Chinook salmon in the Cedar River and Lake Washington, including the Ship Canal between Union Bay and the Hiram Chittenden Navigation Locks. SPU and Dave Beauchamp developed an initial list of worst-case scenario topics and the underlying assumptions prior to the workshop:

1. Predation on juvenile Chinook in Lake Washington during February through July.
2. Predation on juvenile sockeye in Lake Washington throughout the year.
3. Predation on age 0-1 smelt in the lake throughout the year.
4. Predation on Chinook fry and smolts in the Cedar River.
5. Predation on naturally reproduced sockeye fry in the Cedar River.
6. Competition for food between juvenile hatchery and wild sockeye salmon in Lake Washington throughout the year.

The panel discussed these topics in terms of relative importance and whether some should be removed or others added to the list. The final list of topics was prioritized to facilitate efficient discussion and to ensure that the most critical topics were discussed first. Based on this initial

screening, predation on smelt was removed as a topic for direct discussion, but the effect of cyclic smelt abundance was considered as a factor that could mediate predation effects on juvenile salmon.

Response variables used to assess impacts

For each remaining topic, the panel discussed and selected the most appropriate response variable (e.g., a percentage change in the survival rate of juvenile salmon) for determining impact, based on biological relevance to the populations of interest, conceptual clarity, and measurability. The panel agreed that the most appropriate response variable for assessing impact would be the percentage change in survival of juvenile sockeye or Chinook salmon that could result from the new hatchery operations under "worst-case" conditions, compared to current baseline conditions. Although survival rates cannot be measured directly for juvenile Chinook and sockeye salmon in the Cedar River, or for Chinook salmon in Lake Washington, reasonable indirect measures of survival can be estimated to provide useful indices of measurable changes in relative survival in the Adaptive Management Plan. Indices of survival for both sockeye and Chinook salmon in the Cedar River can be calculated by dividing the abundance of juvenile salmon at the migrant trap by either the estimated egg deposition (fry/egg ratio) or number of spawners (fry/spawner ratio). Lake-phase survival for juvenile sockeye salmon can be estimated by dividing the estimate of fry entering the lake (from migrant trapping) by the abundance of pre-smolts estimated from the annual hydroacoustic-midwater trawl surveys during the end of March. Unfortunately, survival of sockeye pre-smolts cannot be estimated from the end of March until the smolts pass through the Locks by the end of May. No method currently exists for directly estimating survival of juvenile Chinook salmon during lake residence. Adult returns could potentially be used as a secondary index of freshwater survival, but will include the additional confounding factor of interannual variability in marine survival rates that cannot be separated from freshwater processes.

General assumptions used for worst case analysis

The potential impacts of predation and competition were evaluated by applying a combination of existing information, theory, and expert opinion to a prescribed set of "worst-case" conditions to predict how survival would differ from current conditions. Basic underlying assumptions for each worst-case scenario were discussed, clarified, and modified, and new assumptions were included if necessary. The current annual production of up to 17 million sockeye fry by the interim hatchery (i.e., the mid-1990s to 2004) was considered the existing baseline condition from which the panel predicted potential "worst-case" impacts imposed by new hatchery operations. The worst-case scenario assumed that the new hatchery would produce the maximum capacity of 34 million sockeye salmon fry per year. In extremely rare circumstances, natural fry production in the Cedar River could presumably be 25% greater than the highest production level recorded to date, thus leading to a combined total of 80-85 million wild and hatchery fry migrating down the Cedar River. Under the current interim hatchery, most hatchery fry migrate down the Cedar River several weeks earlier than wild fry. The worst-case analysis considered the effects of a shift in peak migration timing by hatchery fry to coincide with peak migration of naturally spawned fry.

Worst case assumptions for competition analysis
Some worst-case conditions for competition scenarios differed from those for predation scenarios. Competition would be most severe when the abundance of potential competitors (e.g., sockeye salmon fry and age-1 pre-smolts, threespine sticklebacks, and age-1 longfin smelt) was maximized (Beauchamp 1996; Beauchamp et al. 2004b). Therefore, the ***worst-case scenario for competition assumed that***:

1. A combined 80-85 million wild and hatchery sockeye salmon fry migrated to the lake with coinciding peak lake-entry times by both hatchery and wild fry (this assumes that the proposed lower incubation temperatures for hatchery fish would delay their outmigration to coincide with outmigration timing of wild fry). The interim sockeye hatchery cannot provide the colder natural temperature regime experienced by naturally spawned embryos. Consequently, hatchery fry migration currently peaks 3-4 weeks earlier than wild fry. The worst case scenarios assumed that improved temperature control under the new hatchery would shift peak hatchery migration later to coincide with the peak for wild migrants.

2. The co-occurring cohort of age-1 sockeye salmon pre-smolts were also generated from 80 million fry from the previous year, and experienced an annual lake-phase survival rate of 8% (the maximum fry-pre-smolt survival rate from a range of 4-8% estimated for 2001-2002 and 2002-2003; Beauchamp et al. 2004a). Thus, 6.4 million sockeye pre-smolts co-occurred with 80-85 million fry and fed on the same forage base.

3. Large populations of sockeye fry and pre-smolts also coincided with relatively high abundances of competing planktivores: 4 million threespine sticklebacks, and 15 million age-1 longfin smelt (representing high abundance from a strong year class of age-1 smelt).

4. The timing and abundance of Chinook and coho salmon released from the Issaquah Hatchery[1] would not differ from current levels.

Worst case assumptions for predation analysis
In contrast, higher abundance of these small-bodied fishes, particularly longfin smelt, reduced predation on sockeye salmon (Beauchamp 1994; Nowak et al. in press; Mazur 2004). Therefore, the ***worst-case predation scenarios assumed that:***

1. The combined maximum production of 80-85 million wild and hatchery sockeye fry entered the lake with coinciding peak migrations.

[1] The UW Hatchery releases far fewer smolts than the Issaquah Hatchery, and the UW Hatchery is "downstream" of the lake and Cedar River. UW Hatchery fish would contribute to predator buffering/attraction effects in the Ship Canal. However, since their timing overlaps with the outmigration of other wild and hatchery smolts, no special consideration was afforded them.

2. Significantly lower numbers of sockeye pre-smolts (e.g., 1.0 million), threespine sticklebacks (1.0 million), and age-1 longfin smelt (1.0 million) co-occurred in the lake during winter and over the subsequent year, thus providing fewer alternative prey for predatory fish.

3. The timing and abundance of Chinook and coho salmon released from the Issaquah Hatchery would not differ from current levels.

Analysis process used during workshop

Analysis of each topic began with a brief presentation of the theoretical mechanisms driving predation or competition, identification of any important mediating factors, and a summary of relevant published or unpublished data specific to the Cedar River-Lake Washington basin. The panel was asked to predict how the response variable might change under the worst-case scenarios in comparison to current existing conditions.

For each topic, the discussion leader presented an example set of predictions about how survival might change under the worst-case scenario and the underlying rationale for these predictions. These "straw-horse" predictions were used to stimulate discussion about appropriateness of how responses were conceptualized and to elicit initial predictions of worst-case responses from the other members of the panel. After discussion and potential modification of the original "straw horse" prediction, each panelist added their own prediction of how the response variable would change under the worst-case scenario. Each panelist provided a point estimate of the most likely change in response (e.g., a net positive or negative impact), and drew a line that represented the direction and range of potential responses around the point estimate. These lines indicated the range of uncertainty from each panelist, based on current knowledge of the system, the perceived level of either ambient variability in the system, or potential environmental trends that would be beyond the control of the hatchery management plan (e.g., global warming, continued land development, etc.).

Worst-case effects of the hatchery were categorized into neutral, minor, medium, and major impacts. Neutral impacts would show no biologically significant change on the population of interest. Minor impacts could involve small positive or negative shifts in the response variable, but would have no lasting biological impact on the population. Medium impacts could result in moderate and perhaps lasting biological effects (e.g., a reduced or expanded population). Major impacts would represent large, lasting changes in the populations, including extinction.

Predation

Both direct and indirect effects of increased hatchery production of sockeye salmon fry on predator-prey interactions were considered in the Cedar River, Lake Washington, and the Ship Canal. Increased hatchery production could affect predator-prey interactions in a variety of ways. First, more hatchery fry could serve as "predation buffers" by absorbing some of the existing predation pressure, thus increasing survival by wild sockeye and Chinook salmon in the river or the lake. Alternatively, a larger and more consistent seasonal influx of hatchery fry could increase predation by either attracting more of the existing predator population to key interception points when juvenile salmon were especially vulnerable (i.e., to the Cedar River or

Ship Canal during juvenile salmon migrations) or by increasing predator abundance through enhancing their reproductive success (termed a "numerical response").

Increasing predators through attraction or reproduction could increase predation and reduce survival for either wild sockeye or Chinook salmon. However, to stimulate higher reproductive success by predators, juvenile sockeye salmon must represent a significant fraction of the energy budget for the predators, such that increased predation in response to higher hatchery production would increase gonadal investment, or increased juvenile survival and recruitment by the predator populations. Because sockeye salmon currently contributed less than 10% of the annual prey biomass consumed by cutthroat trout, northern pikeminnow, and other piscivores in the lake (Mazur 2004) and contributed even less to sculpin species in the Cedar River (Tabor et al. 1998, 2004), the panel concluded that increased hatchery production of sockeye salmon would not increase predator abundance or biomass. However, the panel believed that the potentially conflicting effects of predation buffering and predator attraction were plausible responses to increased hatchery production of sockeye fry, and the net effects could differ between juvenile Chinook and sockeye salmon in the Cedar River, Lake Washington, or the Ship Canal.

A habitat-specific juvenile life history table was developed to guide the panel discussion and summarize the predicted stage-specific responses of sockeye and Chinook salmon during the downstream migration and lake entry from the Cedar River, lake-rearing, and outmigration through the Ship Canal (Table 1).

Table 1. Life stage-specific responses of juvenile Chinook salmon to potential worst-case impacts of competition and predation.

Worst-case responses by juvenile Chinook salmon in the Cedar River and Lake Washington	Competition Impacts (growth response)	Predator Impacts (i.e. effects of buffering or attraction on survival)
Lake entry	Neutral	Neutral (perhaps slightly negative)
Early shoreline rearing	Neutral	Neutral
Dispersal offshore – nearshore	Neutral	Neutral
Outmigration (through Ship Canal)	Neutral	Neutral (perhaps slightly negative)

Predation on juvenile Chinook salmon in the Cedar River during winter

Sculpins, rainbow trout, and cutthroat trout are important predators on juvenile salmon in the Cedar River (Tabor et al. 2004). Predation on juvenile Chinook salmon fry survival in the Cedar River was more likely to be affected by the proposed delay in migration timing of hatchery fry than by an increase in fry abundance. Under current conditions, hatchery sockeye fry migrations overlap with the early peak in wild Chinook fry migration (Figures 1-2), and presumably provide a predation buffer for Chinook fry. This potential buffering effect on predation mortality might be reduced by shifting the migration timing of hatchery sockeye fry later in order to achieve a stated hatchery management objective of emulating the wild run timing.

The potential decline in survival due to a reduction in predation buffering might be moderated by both biological and environmental factors. Despite the shift to later peak migration by hatchery sockeye, increased hatchery production would still increase the abundance of the earliest portion of the hatchery run, coinciding with the early-emerging wild sockeye fry (Figure 1). The impact of less predation buffering would be dampened by the higher stream flows and low temperatures during February. Lower temperatures reduce predation by reducing activity and metabolic demands by predators, and higher flows reduce predatory efficiency by sculpins and salmonids feeding on fry in the Cedar River (Tabor et al. 1998, 2004; Seiler et al. 2001). Lake predators like northern pikeminnow and cutthroat trout were unlikely to be more attracted to the mouth of the Cedar River by higher sockeye fry production. For instance, although northern pikeminnow shifted toward the Cedar River during winter, they appear to be tracking the prespawning aggregation of adult longfin smelt rather than the immigration of juvenile salmon.

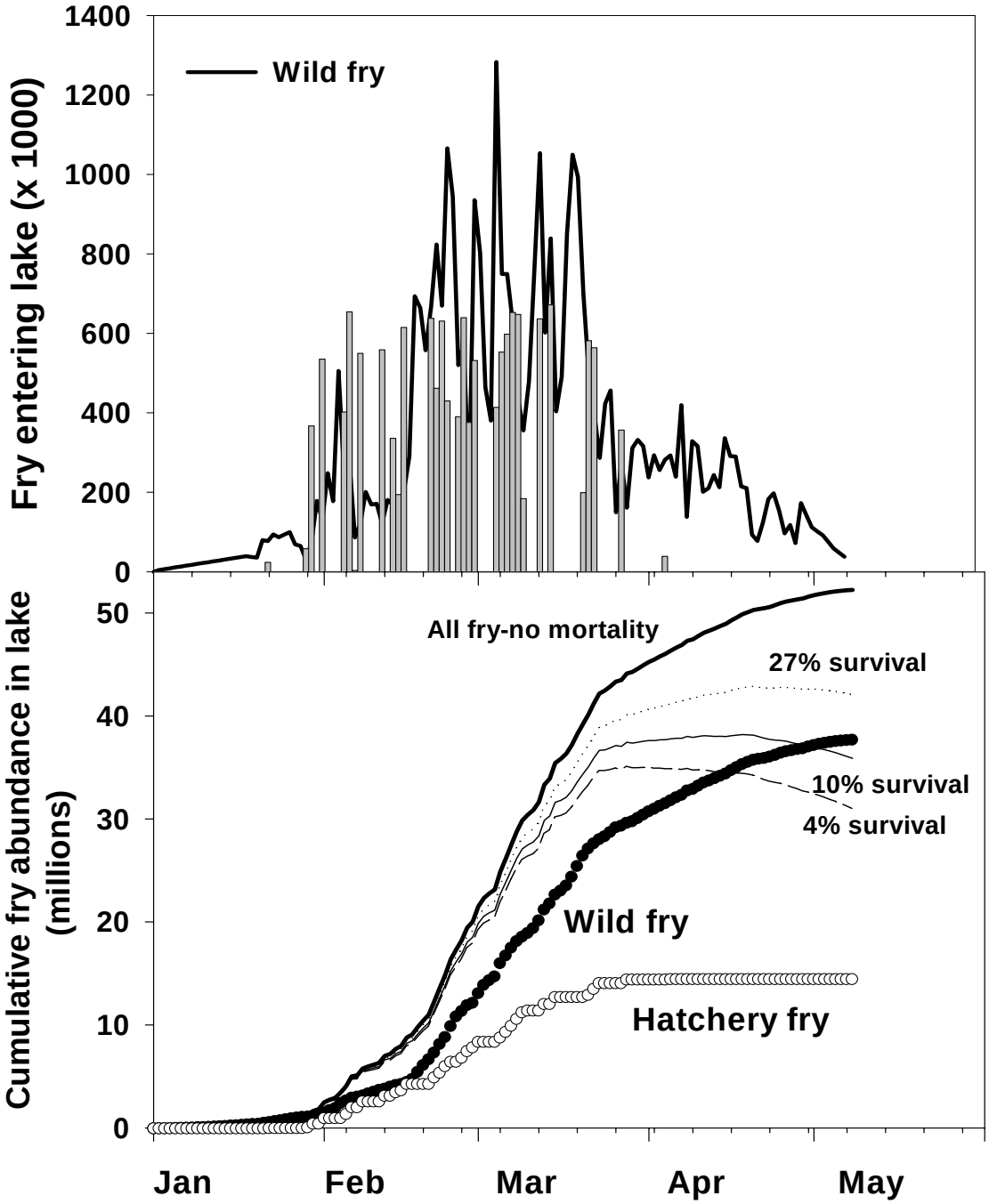


Figure 1. Wild (solid line) and hatchery (gray bars) sockeye fry migration timing from the Cedar River (top panel), and cumulative abundance entering Lake Washington (bottom panel) during 2001. Peak hatchery migration precedes the wild peak by 3-4 weeks. Although not true in 2001, the abundance of hatchery sockeye fry can exceed wild fry during the peak Chinook fry migration in February (Figure 2) during some years (from Beauchamp et al. 2004).

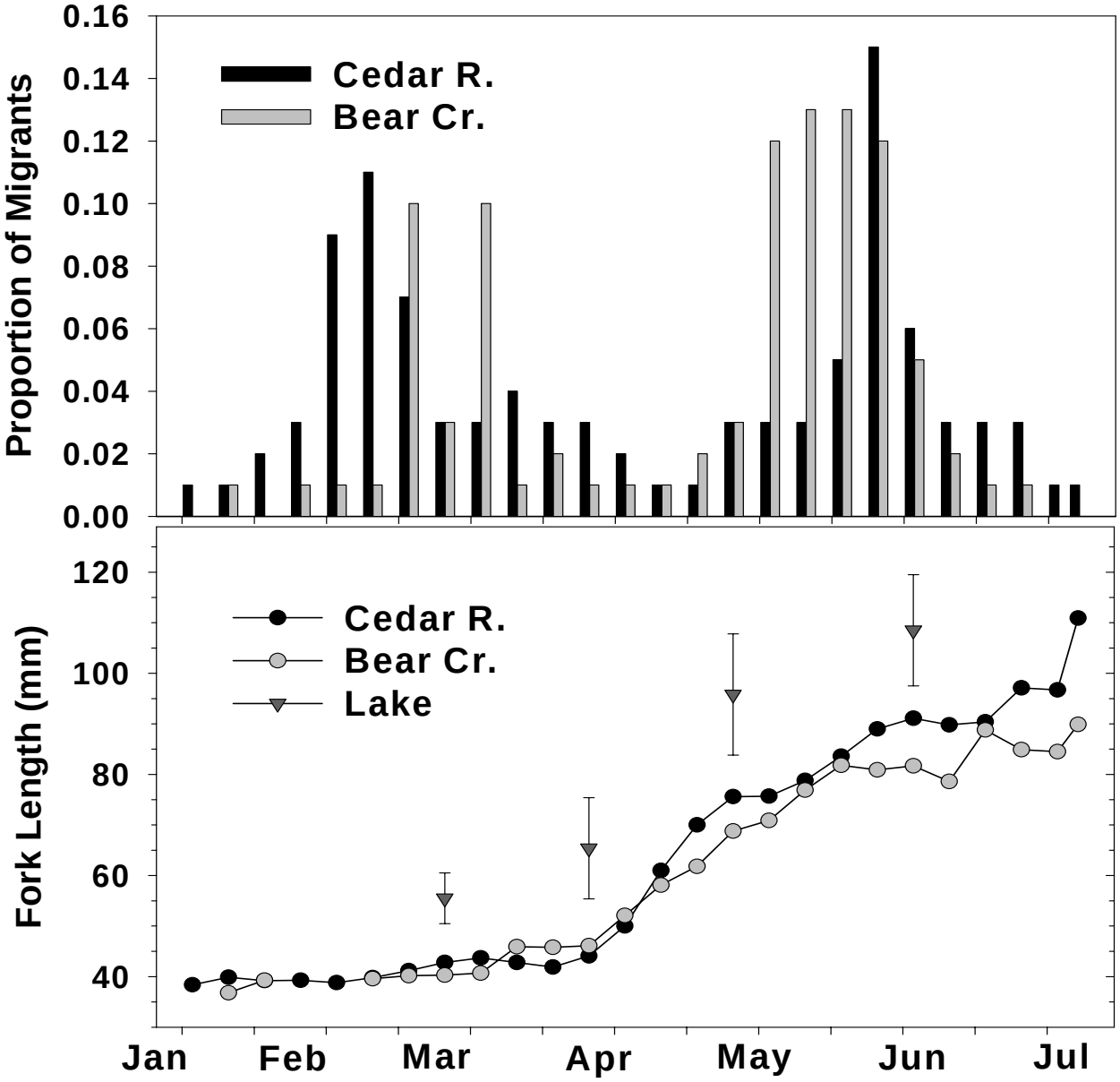


Figure 2. Juvenile Chinook salmon enter the lake in two pulses (Upper panel) from both the Cedar River in the south and Bear Creek in the north via the Sammamish Slough. Chinook fry are consistently larger in the lake than in the streams (Lower panel). For comparison, sockeye fry average 32 mm FL in late March and 40 mm FL in early May.

Although the panel agreed that the worst-case scenario for predation would have neutral or minor impacts on Chinook salmon fry survival in the Cedar River, the panelists differed somewhat in the direction and magnitude of potential impacts (Figure 3). Frodge and Schindler predicted a minor reduction in Chinook fry survival due to reduced predation buffering if hatchery sockeye migration timing was shifted later. Their uncertainty was skewed toward a neutral impact. Beauchamp and Seiler predicted a neutral impact on survival with uncertainty skewed slightly toward improved survival. These predictions were based on the assumption that higher flows and cold temperatures would minimize the ability of predators to eat more Chinook fry, and that the ambient abundance of wild and hatchery sockeye fry would not change enough to reduce the predation buffer, despite a shift toward later peak migration by hatchery fry. Fresh and Tabor both predicted a neutral impact with symmetric, low levels of uncertainty. The overall assessment of the panel was characterized as neutral to minor predation impacts on Chinook fry survival in the Cedar River.

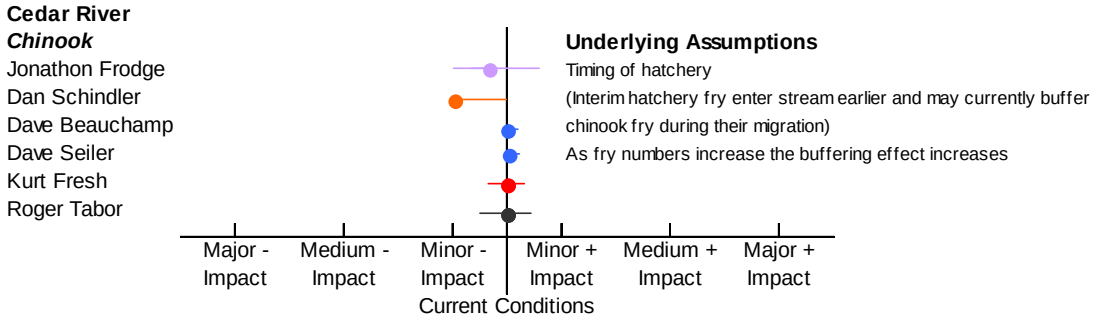


Figure 3. Panelists' worst-case predictions for how survival of Chinook salmon fry in the Cedar River would change in response to the new sockeye salmon hatchery. The consensus of the panel was that all impacts would be neutral or minor (<10% shift from the current survival rates). The vertical line indicates a neutral response. Survival improves to the right and declines to the left of the vertical line. The symbols represent each panelist's prediction of the most likely impact, and the lines represent the direction (positive or negative) and range of uncertainty around each prediction.

Predation on juvenile sockeye salmon in the Cedar River during winter

All panelists agreed that a minor improvement in survival of sockeye salmon fry would result under the worst-case scenario, primarily in response to an increase in self-buffering against predation throughout the outmigration period in the Cedar River (Figure 4). In other words, the presence of more sockeye fry would buffer the fry against predation, such that a lower percentage of the population is consumed as fry abundance increases. Uncertainty in these predictions was primarily skewed toward greater improvement in survival.

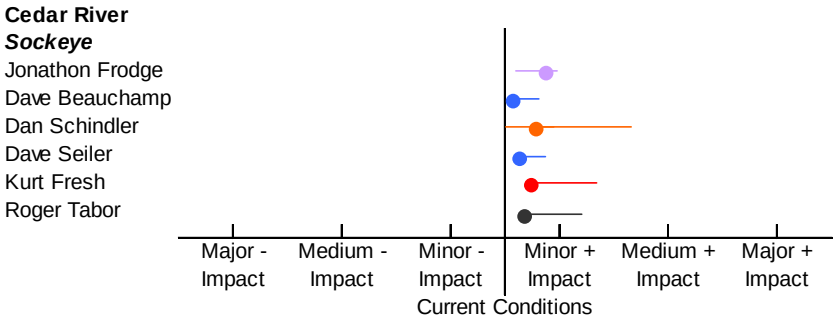


Figure 4. Panelists' worst-case predictions for how survival of sockeye salmon fry in the Cedar River would change in response to the new sockeye salmon hatchery.

Predation on juvenile Chinook and sockeye salmon in Lake Washington

Again, the primary impact on juvenile Chinook salmon survival in the lake was predicted to be in response to increased spatial overlap with predators through attraction of predators to the more abundant hatchery sockeye fry, fingerlings, and smolts. Because juvenile Chinook and sockeye salmon rapidly segregate into different habitats during lake rearing, the influence of increased hatchery sockeye production would be confined to either nearshore zones in close proximity to the Cedar River mouth for immigrating and rearing Chinook fry, or through the Ship Canal for emigrating Chinook smolts. Chinook fry reside in shallow nearshore habitat in the southern third of the lake from February through early May (Tabor et al. 2004). In contrast, sockeye salmon fry migrate rapidly into open water habitat with only a small fraction of the migrants overlapping briefly with juvenile Chinook in nearshore habitats close to the Cedar River (Martz et al. 1996; Beauchamp et al. 2004). Small cutthroat trout and northern pikeminnow are relatively abundant in nearshore regions during the winter and will feed on juvenile salmon (Nowak et al. in press; Mazur 2004), but cold temperatures during this period would reduce consumption rates of the predators. Therefore, the panel agreed that higher sockeye fry production could potentially attract or retain more predators in nearshore habitats within several kilometers of the Cedar River mouth and potentially lead to a minor reduction in survival of Chinook salmon fry. The cyclic, 10-fold fluctuation in abundance of longfin smelt will have a much greater influence on predation mortality in both nearshore and offshore habitats during winter than any increase in sockeye fry abundance.

A 25-100% increase in juvenile sockeye salmon was not expected to influence seasonal predation effects on either sockeye or Chinook salmon in offshore habitats when dispersed over the volume of a large lake, especially when compared to the 10-fold change in abundance of longfin smelt that cycles between even- and odd-numbered years.

Sockeye smolts primarily migrate through the Ship Canal during May, whereas Chinook and coho smolts migrate during June and July. More sockeye smolts could potentially attract and retain more predatory smallmouth and largemouth bass in and around the Ship Canal, which could potentially increase predation on Chinook smolts. However, during April-May, the Issaquah Hatchery releases millions of coho and Chinook smolts that feed in the lake and migrate through Ship Canal in June-July at abundances and body sizes that are comparable to the sockeye smolts. Therefore, under worst-case conditions, an increase in sockeye smolts would

have a neutral effect or perhaps a minor reduction in survival of Chinook smolts migrating through the Ship Canal.

The panelists agreed that the worst-case impact of the sockeye hatchery would be neutral or perhaps a minor reduction in survival of both Chinook and sockeye salmon during lake rearing and migration (Figure 5). The primary impacts were attributed to attraction of more predators to localized regions near the Cedar River mouth and to a lesser degree in the Ship Canal. Uncertainty ranged from a minor negative to a minor positive impact on survival of both species.

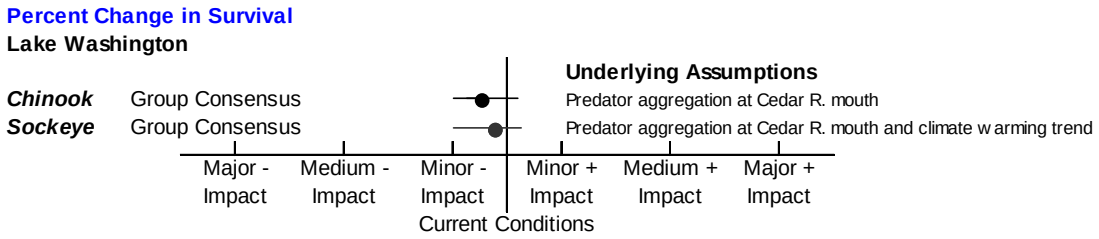


Figure 5. Panelists' worst-case predictions for how survival of juvenile Chinook and sockeye salmon would change in Lake Washington in response to the new sockeye salmon hatchery.

Competition

Increased hatchery production of sockeye salmon fry would increase consumption demand on zooplankton or other shared food resources. If food supply became limiting as a result, then the new hatchery could potentially create negative impacts by increasing competition, reducing growth, and potentially increasing mortality directly through starvation or indirectly by increasing vulnerability to predation because of smaller body size or debilitated condition. However, competition can only occur if a common food resource is limiting.

In Lake Washington, juvenile Chinook salmon feed almost exclusively on chironomid pupae from February until mid-May (Koehler 2002), and grow more rapidly than either Chinook in stream habitats or sockeye in the lake during this period (Figure 2, lower panel). Juvenile sockeye salmon feed primarily on cyclopoid copepods during winter and early spring, but also eat chironomid pupae when captured in nearshore habitats (Beauchamp et al. 2004a).

Zooplankton densities in the southern half of the lake decline dramatically in mid-March through early April (Figure 6). Despite this seasonal decline in food, the largest recorded population of sockeye fry consumed less than 20% of the biomass of exploitable zooplankton available in the southern regions of the lake (Figure 7), where most planktivorous species were distributed during winter and early spring. When the *Daphnia* population increases in mid-May or early June, most planktivorous species switch to this abundant food source, and both sockeye and Chinook salmon feed heavily on *Daphnia* in offshore waters. As the seasons progress, other species consume as much or more zooplankton than juvenile sockeye (Figure 8). Yet despite the increased demand, the combined planktivore community only consumes $\leq$5% of the average monthly biomass of *Daphnia* during the May-November growing season (Beauchamp 1996, and unpublished data).

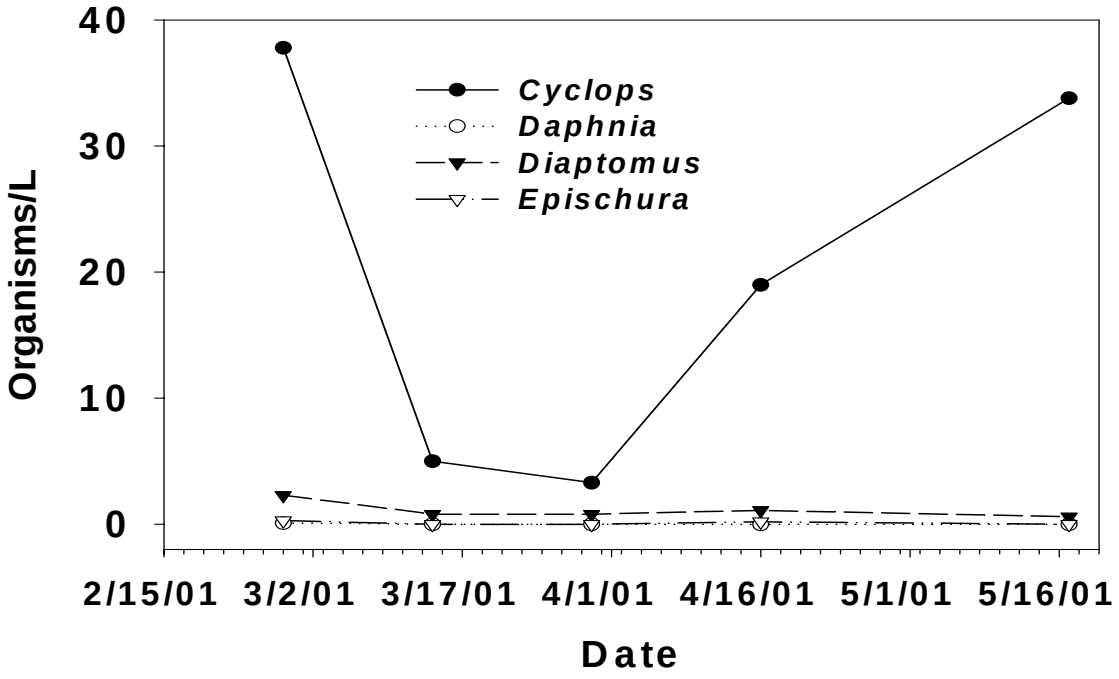


Figure 6. Zooplankton in Area 5 (southern end of the lake) dominated by Cyclops during winter 2001. Cyclops densities declined markedly from early to mid-late March then rebounded in early April (from Beauchamp et al. 2004).

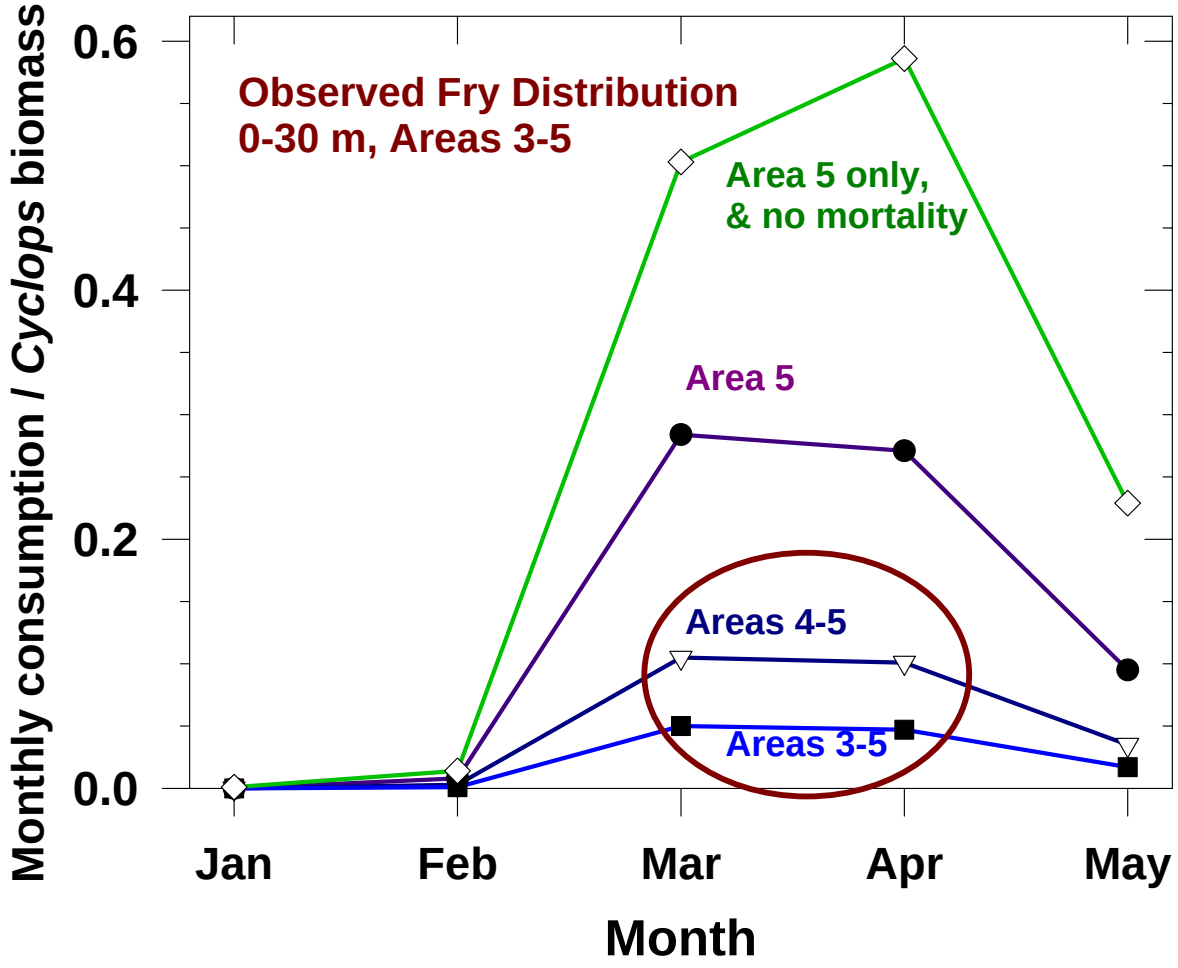


Figure 7. Different food supply and demand scenarios were examined during the early life history of sockeye salmon during 2001, when 52.4 million hatchery and wild fry, the largest recorded number in the history of the lake, entered the southern end of Lake Washington. The scenarios represented different survival and dispersal rates of fry which determined the size of the pool of zooplankton available for consumption. The circle indicates the most realistic scenarios, based on the observed distribution and survival of fry in the lake. During the greatest potential bottleneck in food supply, sockeye fry only consumed 10-15% of the biomass of exploitable zooplankton available in the southern end of the lake. (From Beauchamp et al. 2004.)

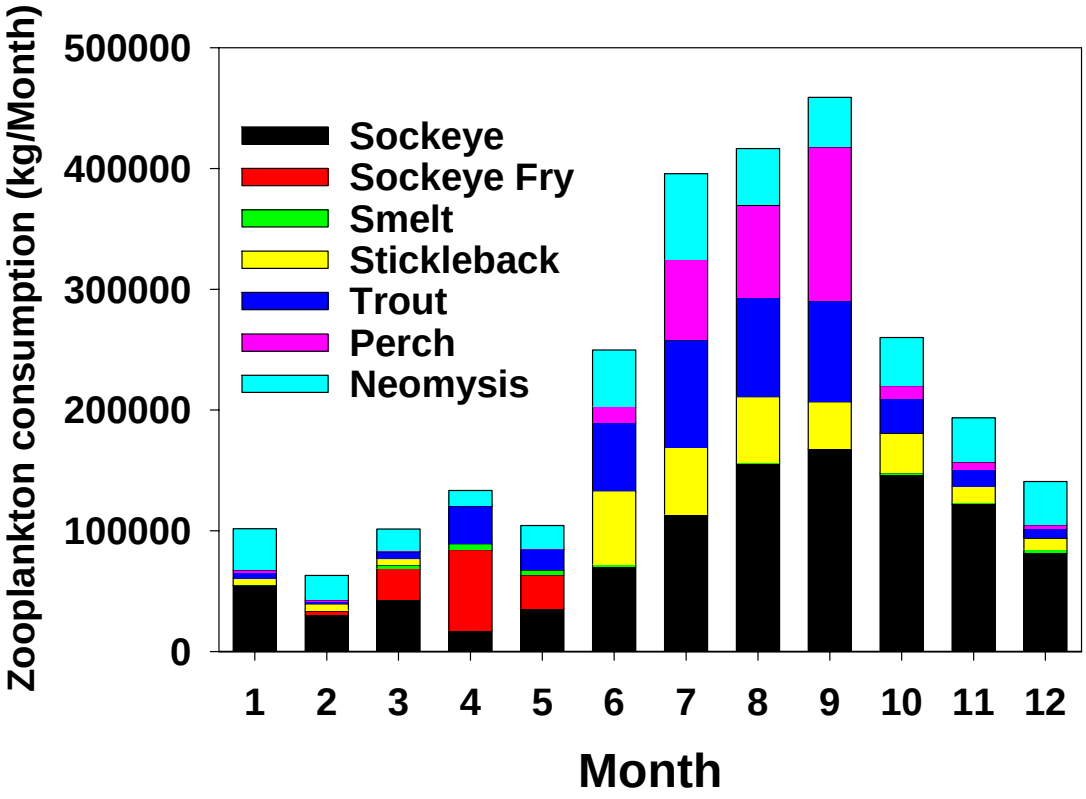


Figure 8. During March-April, sockeye fry and pre-smolts were the most important zooplankton predators, but sockeye represented less than half of the total consumption demand during June-September. The estimated total consumption demand by all planktivorous fishes and Neomysis represented approximately 50% of the exploitable zooplankton supply available in March and April, but less than 5% during May-November.

Due to the difference in habitat use and diet between juvenile Chinook and sockeye, and the rapid growth rate of Chinook salmon in the lake during winter and spring, juvenile Chinook salmon in the lake were unlikely to be affected by competition from the higher density of juvenile sockeye assumed under the worst-case scenario. Sockeye salmon were also not likely to be affected by increased competition. No evidence of density-dependent reduction in growth by sockeye fry or smolts was found over a 5-fold increase in fry abundance in the lake (10-52 million fry) over the past decade (Figure 9).

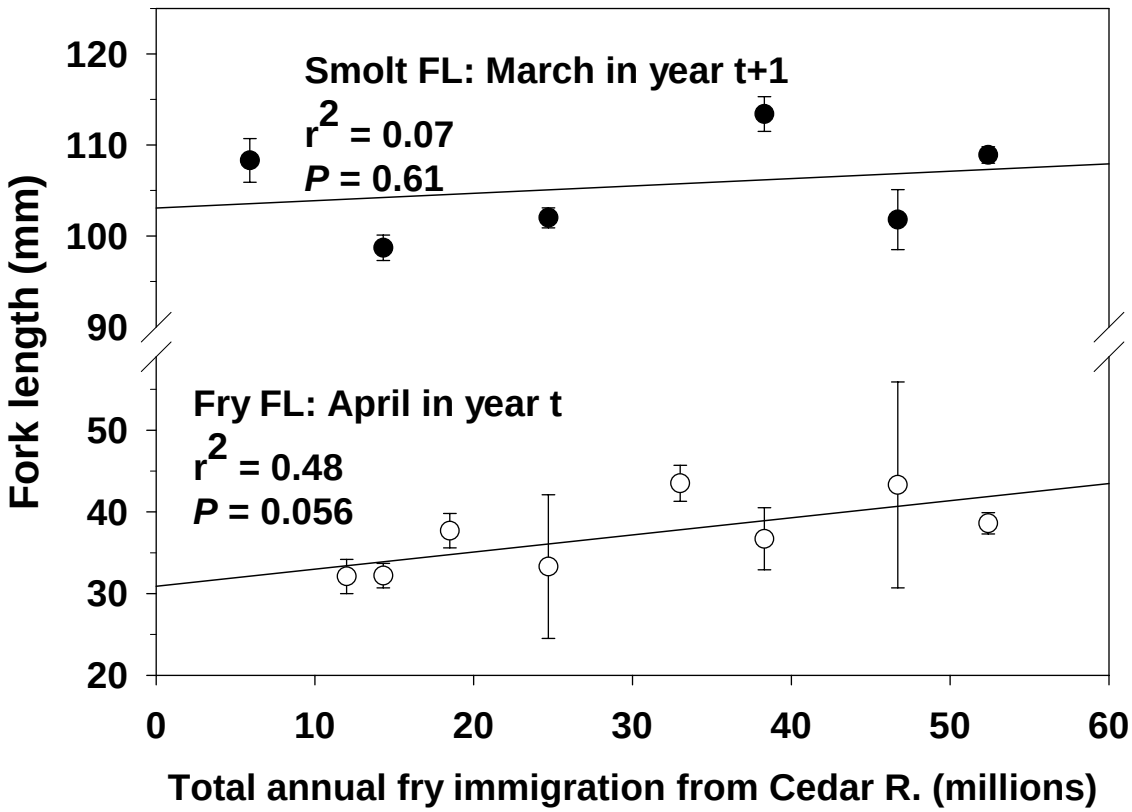


Figure 9. No density dependent growth reduction is evident during either the first winter of growth for sockeye salmon fry or after a year of lake residence by pre-smolts (from Beauchamp et al. 2004).

Caveats

Although not direct consequences of the Cedar River Sockeye Hatchery, several factors need to be monitored because they could significantly change the impact of predatory or competitive interactions in the Cedar River and Lake Washington over the 50-year period of the Habitat Conservation Plan. Long-term warming trends, increased human population density and consequent land development in the basin, invasions or introductions of non-native species, and changes in populations of other key species in the drainage could each have profound effects on survival and growth of salmon and other sensitive species and on water quality in the lake.

Therefore, the Adaptive Management Plan for the hatchery may need to adjust operations in response to these or other environmental or ecological changes in order to maintain some balance in the structure and function of the ecosystem. Some specific concerns are listed below.

1. Lake temperatures have increased significantly over recent decades. Thermal increases could shift the timing of plankton blooms, fish migrations, spawning, and hatching, and could create or intensify thermal barriers to smolt or adult migrations. Warming could also reduce *Daphnia* biomass and productivity while increasing consumption demand on them by planktivorous fishes. Competition for zooplankton would become a more important impact on salmon production, and lake clarity could become significantly degraded. As water clarity declines, predation on sockeye and other planktivorous fishes would also decline and potentially exacerbate the effects of competition and water quality. Although more juvenile sockeye might survive the lake-rearing phase under this scenario, the smolts would be smaller and severe marine mortality would likely cause a significant net decline in adult returns.

2. Increasing land development and demand on water could further degrade spawning, incubation, and rearing capacity in the streams, limit access to migration corridors, and further degrade water quality in the lake. All of these processes would reduce production of sockeye and Chinook in the basin.

3. Changes in key species (expanding abundance of predatory cutthroat trout, loss of longfin smelt or *Daphnia*, introductions of zebra mussels, whirling disease, exotic zooplankton or fish) could significantly alter predator-prey and competitive interactions in the basin. Cyclic fluctuations in smelt offer a prime example of this. Mortality on sockeye, smelt, and potentially other salmon has been significantly higher when weak year classes of smelt are present in the lake. These impacts occur from fall of odd-numbered years through the summer of even-numbered years. Smelt serve as an important buffer to predation on sockeye and other fishes. Smelt also control the abundance of *Neomysis* in the openwater regions where *Neomysis* might otherwise depress or eliminate *Daphnia*. Therefore, if the weak year classes of smelt are depressed further by increased predation, etc., profound impacts could affect everything from growth and abundance of top predators, salmon, zooplankton, and degrade water quality.

References

Beauchamp, D.A. 1994. Spatial and temporal dynamics of piscivory on planktivorous fishes: Implications for food web stability and the transparency of Lake Washington. *Lake and Reservoir Management* 10:21-24.

Beauchamp, D.A. 1995. Riverine predation on sockeye salmon fry migrating to Lake Washington. *North American Journal of Fisheries Management* 15:358-365.

Beauchamp, D.A. 1996. *Modeling the Carrying Capacity for Zooplanktivorous Fishes in Lake Washington.* Final Report to Washington Department of Fisheries and Wildlife. Olympia, WA.

Beauchamp, D.A., M.M. Mazur, J.K. McIntyre, J.H. Moss, and N.C. Overman. 2002. *Trophic Dynamics of Fishes and Zooplankton in Lakes Washington and Sammamish.* Annual Report to King County Division of Land and Water Resources, SWAMP Program. Washington Cooperative Fisheries and Wildlife Research Unit Report WACFWRU-02-01.

Beauchamp, D.A., C. Sergeant, M.M. Mazur, J.M. Scheuerell, D.E. Schindler, M.D. Scheuerell, K.L. Fresh, D.E. Seiler, and T.P. Quinn. 2004. Temporal-spatial dynamics of early feeding demand and food supply of sockeye salmon fry in Lake Washington. *Transactions of the American Fisheries Society.*

Beauchamp, D.A., S.A. Vecht, and G.L. Thomas. 1992. Seasonal, diel, and size-related food habits of cutthroat trout in Lake Washington. *Northwest Science* 66:149-159.

Koehler, M.E. 2002. *Diet and Prey Resources of Juvenile Chinook Salmon Rearing in the Littoral Zone of an Urban Lake.* Master of Science Thesis. University of Washington. Seattle, WA.

Martz, M, F. Goetz, J. Dillon, and T. Shaw. 1996a. *Lake Washington Ecological Studies. Study Element II: Early Life History of Sockeye Salmon* (Oncorhynchus nerka) *in Lake Washington, Year 1: 1994.* Final Report, U.S. Army Corps of Engineers, Seattle District.

Martz M., F. Goetz, J. Dillon, and T. Shaw. 1996b. *Supplement to: Lake Washington Ecological Studies. Study Element II: Early Life History of Sockeye Salmon* (Oncorhynchus nerka) *in Lake Washington, Year 2: 1995.* Final Report, U.S. Army Corps of Engineers, Seattle District.

Mazur, M.M. 2004. *Linking Visual Foraging with Temporal Prey Distributions to Model Trophic Interactions in Lake Washington.* Doctoral Dissertation. University of Washington. Seattle, WA.

Nowak, G.M. 2000. *Movement Patterns and Feeding Ecology of Cutthroat Trout* (Oncorhynchus clarki clarki) *in Lake Washington.* Master's thesis. University of Washington. Seattle, WA.

Nowak, G.M., R.A. Tabor, E.J. Warner, K.L. Fresh, and T.P. Quinn. In press. Ontogenetic shifts in habitat and diet of cutthroat trout in Lake Washington, Washington. *North American Journal of Fisheries Management.*

Seiler, D., G. Volkhardt, and L. Kishimoto. 2001. *1999 Cedar River Sockeye Salmon Fry Production Evaluation.* Washington Department of Fish and Wildlife. Fish Program, Science Division Report Number FPA 01-14.

Tabor, R., J. Chan, and S. Hager. 1998. *Predation of Sockeye Salmon Fry by Cottids and other Predatory Fishes in the Cedar River and Southern Lake Washington, 1997.* U. S. Fish and Wildlife Service, Western Washington Office, Aquatic Resources Division, Lacey, WA.

Tabor, R.A., M.T. Celedonia, F. Mejia, R.M. Piaskowski, D.L. Low, B. Footen, and L. Park. 2004. *Predation of Juvenile Chinook Salmon by Predatory Fishes in Three Areas of Lake Washington Basin.* Miscellaneous Report. U.S. Fish and Wildlife Service. Western Washington Fish and Wildlife Office, Lacey, WA.

Report
Worst-Case Scenario

Spawning Ground Competition and Chinook Salmon Redd Superimposition by Sockeye Salmon in the Cedar River

Ernest L. Brannon, Committee Chair

Session: Committee on spawning ground competition and sockeye redd superimposition on Chinook salmon redds.

Objective: To develop the worst-case scenario in the Cedar River for:
(1) Spawning ground competition between sockeye and Chinook salmon.
(2) Chinook salmon redd superimposition by sockeye salmon.

Committee: Committee members were:
Ernie Brannon, Chair, Professor, University of Idaho
Tim Essington, Professor, University of Washington
Steve Foley, Biologist, Washington Department of Fish and Wildlife
Dave Seiler, Biologist, Washington Department of Fish and Wildlife

Facilitator: Linda DeBoldt
Scriber: Brent Lackey
Data consultant: Carl Burton

Background: Sockeye salmon and Chinook salmon are sympatric throughout most of their range when associated with lacustrine systems. Sockeye are usually very abundant because they use stream environments only for spawning and move to nursery lakes for the remainder of their freshwater residence. Lake Washington is very productive, and the Cedar River sockeye fry hatchery program was established in the early 1990s to stabilize the run and help compensate for sport and Indian fisheries in Lake Washington that might have been affected by water diversion from the Cedar for the needs of the City of Seattle. Plans are to expand the hatchery and increase sockeye production up to 34 million eggs annually. Chinook by contrast are a stream resident species during their freshwater period, and are limited by the productivity of the stream environment. Consequently, Chinook salmon are in much lower numbers than sockeye. Furthermore, Puget Sound Chinook are listed as threatened under the Endangered Species Act, including the Chinook in the Cedar River. However, Chinook salmon from the Issaquah Hatchery in the Lake Washington basin including Lake Sammamish and Issaquah Creek also stray into the Cedar River, and may represent a significant proportion of the Cedar River population. However, when examining the question of what potential impact sockeye can have on Chinook salmon in the Cedar River, it is not a comparison of sockeye versus no sockeye, but rather the effects resulting from the additional hatchery fish, or more specifically the difference between approximately 200,000 sockeye presently returning to the

system and 300,000 sockeye expected, including hatchery fish. Our objectives, therefore, deal with increased sockeye production effects rather than the general sockeye effects on Chinook salmon.

Situation: The observation that Cedar River sockeye salmon spawn in areas used by Chinook salmon, and actually superimpose construction of redds in areas overlapping Chinook redds, led to the concern that Chinook spawning success may be negatively impacted by sockeye. Since sockeye are much more numerous than Chinook salmon in the Cedar River with many thousands of sockeye and only a few hundred Chinook, competition with sockeye for spawning sites and the effect of sockeye redd superimposition on Chinook redds were potential impacts of increased hatchery production. The committee was formed to assess these potential problems.

Worst-case definition: (1) The worst-case scenario considered for spawning ground competition is when Chinook salmon are displaced from preferred spawning areas to secondary sites by an abundance of sockeye interfering with Chinook choices, and increased energy expenditure resulting in earlier death and reduced spawning efficiency of Chinook.

(2) The worst-case scenario for the impact of sockeye overspawning on Chinook redds was when large sockeye female digging would intrude into the egg pockets and destroy or excavate the eggs of the Chinook salmon.

Approach: Assessment of the assigned responsibility was to examine the literature on subject matter, and to review the actual experience that committee members had on sockeye and Chinook salmon spawning activity. Each of the committee participants and the data consultant had significant experience on the Cedar River with sockeye and Chinook salmon. The committee first discussed the primary objectives of the session and decided on parameters for those objectives, and then under the worst-case scenario assessed what level of risk the increased level of sockeye production expected from the hatchery would have on spawning site competition and overspawning of Chinook salmon redds.

Response parameters: (1) Chinook salmon spawning ground competition response parameters associated with reduced Chinook salmon survival involved:

(a) Increased energy expenditure guarding redds and early death.
Metric was female redd “guarding” life.
(b) Displacement from site to lesser site quality.
Metric was site selection in presence and absence of sockeye.
(c) Movement further upstream to avoid sockeye.
Metric was Chinook distribution with sockeye density.

(2) Sockeye redd superimposition on Chinook redds response parameters associated with reduced Chinook egg and alevin survival were:

(a) Surface overlap of sockeye redds on Chinook redd.

Metrics were (1) the percent overlap of redds, (2) the percent of females large enough to penetrate Chinook egg pockets.

(b) Siltation increase.
Metric was reduced egg survival.

Basic assumptions:

(1) Competition for redd sites:

(a) Chinook are not displaced by sockeye through aggression, since they dominate on the spawning grounds.

(b) Chinook may move to areas where sockeye are not present, but their secondary site is no less effective than the primary site.

(c) Chinook spawn at greater depth and velocity than sockeye.

(d) Chinook are not displaced to poor quality sites because of interference by sockeye.

(e) Scour susceptibility at secondary site does not appear greater than primary site, but uncertain of what difference there may be between sites.

(f) Energy expenditure of Chinook is not very extensive in aggression toward sockeye. Female Chinook are more assertive than males in defending sites, and males may chase sockeye males, but competition is primarily species-specific except perhaps by disturbance from sheer numbers of fish around the redd site of the Chinook.

Discussion on Competition:

Potential effects of sockeye density on Chinook salmon site selection appear to be primarily a nuisance factor. Chinook dominate on the spawning grounds and do not make much of an effort to chase off sockeye compared to Chinook/Chinook interaction. Also sockeye tend to avoid Chinook and show no aggression against Chinook. Because Chinook spawn in deeper and faster water, they can easily avoid sockeye by moving to such locations without difficulty and without greater risk to Chinook egg survivability. Chinook often spawn in areas not suitable for smaller fish such as sockeye. Chinook appear to select different sites when sockeye are more numerous than in years when sockeye are less abundant, and therefore Chinook may be avoiding the annoyance of a large number of sockeye by moving to sites sockeye are not able to occupy. Energy expenditure by Chinook defending the female or the redd site was considered minor compared with the intraspecific interaction of Chinook. The parameter of Chinook distribution forced further upstream by sockeye density was discussed, but it was not considered as likely of a response as moving to deeper water. Spawn timing is related to temperature, and sites tend to be specific for temperature reasons, with early fish spawning at locations different than later spawning fish. This suggests that deeper or faster water would be the alternative for Chinook rather than moving upstream or downstream any distance to avoid sockeye density. There was good agreement in the committee about the response parameters and in the level of potential risk under the worst-case scenario on both parameters considered.

(2) Superimposition of Chinook redds by sockeye.

(a) Redd depth is related to fish size.

(b) Chinook redds are deeper than sockeye redds because of their greater size.

(c) Chinook egg pockets contain large substrate that cannot readily be moved by sockeye.

(d) The potential risk from disturbance of Chinook eggs is limited to the largest sockeye, and assumed to represent only 5% of the sockeye females.

(e) A sockeye redd will constitute about 10-15% of the area occupied by a Chinook redd.

(f) Average worst-case would be 2 to 3 sockeye redds on a Chinook redd.

Discussion on Super-imposition: Superimposition is a description of one salmon or trout creating a redd on top of another previously established redd. Superimposition is when any part of the redd diameter overlaps with any part of another redd diameter, and consequently, damage to the first redd depends on the nature of the intrusion. If no eggs are dislodged, there is still the possibility that silt will infiltrate around the eggs of the associated nest sites and result in some suffocation if the alevin stage is not reached or mobile enough to escape. While species differences exist in average redd depth, the primary factor responsible for spawning depth is fish size. Based on size data provided by committee members, the smallest Chinook female is 1 standard deviation (15%) larger than the largest sockeye female. Therefore, potential impact is limited to only the largest sockeye. Chinook also dig deeper and in larger substrate, and the remaining cobble that defines the nest pocket is too large for sockeye to move easily, and thus provides a protective barrier to direct intrusion by sockeye digging activity. Redd guarding life of the Chinook female also is a limiting factor. Sockeye have been observed to move onto Chinook redds as soon as they are vacated, but Chinook eggs are not as susceptible to direct shock abuse after 10 days of development, and female stream-life covers all or most of that period, which means that during most of the sensitive embryo development stage the eggs will be protected by the guarding female on the redd. Once the female vacates the redd, mortality of eggs after that 10-day period will have to be from excavation rather than just disturbance. Eyed eggs will be susceptible to loss by predation once out of the nest pocket, but alevins have the tendency to re-burrow in the gravel and remain hidden. With the larger substrate that defines the nest pocket, the committee agreed that the risk to eggs and alevins would not be from shock abuse, and only a slight risk of excavation by large sockeye females. Siltation was dismissed as a limiting factor because of the lack of silt observed from spawning fish.

Committee Assessment: (1) Competition for redd sites involved independent assessment of the two parameters, (a) energy expenditure and (b) displacement, that the committee decided are most relevant to Chinook salmon survival reduction with the increased sockeye production planned from the Cedar River hatchery. On the

first parameter (a), the committee agreed 100% that under the worst-case scenario, the influence of energy available for spawning by Chinook salmon would not be reduced significantly. Reduced survival from energy expenditure was rated at 0 to 10% impact. The second parameter (b), displacement of Chinook from preferred spawning sites by high sockeye densities, was also considered of low impact. Chinook use sites not directly comparable to sockeye sites. The possibility that Chinook would experience higher egg mortality if they were displaced varied among committee members, with assessments ranging from 50 to 100% probability of a 0-10% impact, and 25 to 50% probability of a 10-20% impact (Figure 1 and 2).

Figure 1
Energy Expenditure of Chinook Salmon Defending Redd Site

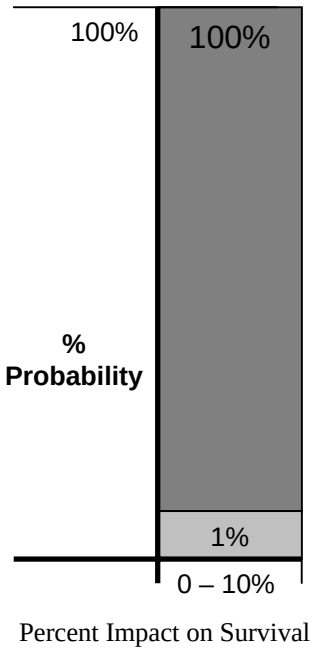
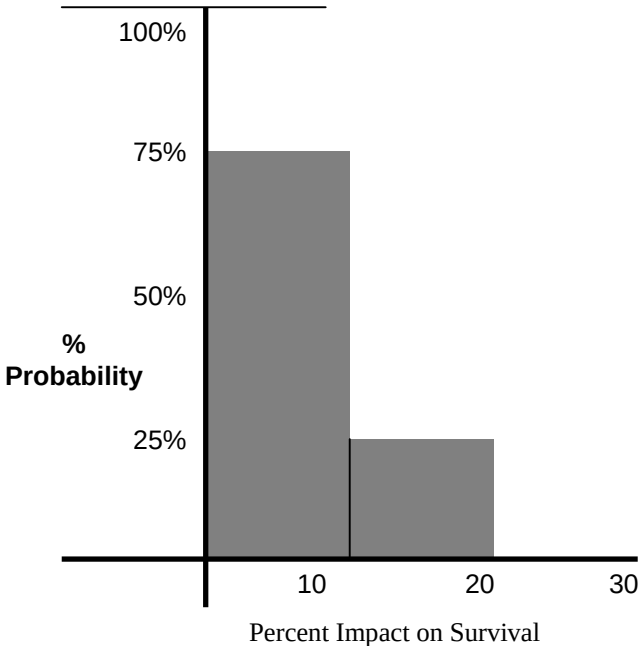


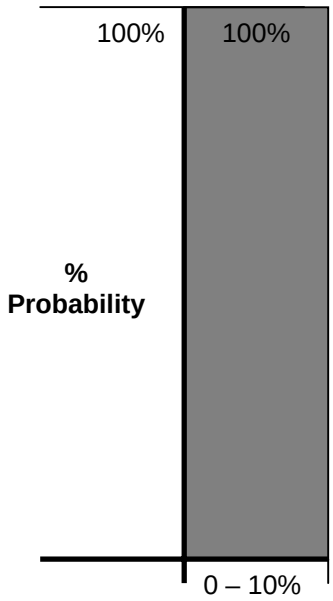
Figure 2
Displacement of Chinook Salmon From Redd Sites



(2) The superimposition of Chinook redds by sockeye spawning activity included only one parameter, after siltation was dismissed as a minor influence on incubation success. The area of a Chinook redd superimposed by sockeye was considered 10 to 15%, and under worst-case scenario could involve 2 to 3 females which would be an estimated 31% of the Chinook redd surface area, times the percent of the sockeye females large enough (5%) to penetrate to the depth of the egg pockets of Chinook redds, giving a probability of impact at only 1.5%. Therefore, even if there were total egg mortality accompanying those intrusions, only a small proportion of the egg population would be affected. The committee

was in agreement that the impact from redd superimposition would be minor and placed the probability between a 0 to 10% impact (Figure 3).

Figure 3.
Impact of Chinook Redd Superimposition
by Sockeye Redd Construction



Percent Impact on Survival

Summary: The members of the Committee on Spawning Ground Competition and Sockeye Redd Superimposition on Chinook Salmon Redds were in close agreement that increased sockeye abundance in the Cedar River would have low impact on Chinook salmon through spawning site competition or redd superimposition. The minimal effect of sockeye on Chinook salmon productivity is confirmed by state enumeration data showing the year of highest sockeye spawning density coincided with the highest Chinook salmon fry survival in the river. One committee member pointed out that predation of Chinook fry in the river, which was not covered in the subject matter of this session, appears to be diverted by predation on the more numerous and smaller sockeye fry. So regarding sockeye impacts on Chinook salmon, there appears to be a low probability of any negative effects, and if there is a relatively low impact of sockeye, it appears that it would be compensated for by the positive effects of increased sockeye density in the Cedar River.

References:

Crisp, D.T., and Carling, P.A. 1989. Observations on siting, dimensions and structure of salmonid redds. J. Fish Biol. **34**: 119134.

DeVries, P. 1997. Riverine salmonid egg burial depths: review of published data and implications for scour studies. Can. J. Fish. Aquat. Sci. **54**: 16851698.

Elliott, J.M. 1984. Numerical changes and population regulation in young migratory trout *Salmo trutta* in a lake district stream, 196683. J. Anim. Ecol. **53**: 327350.

Essington, T.E., T.P. Quinn, and V.E. Ewert. 2000. Intra- and interspecific competition and the reproductive success of sympatric Pacific salmon. Can. J. Fish Aquat. Sci. **57**: 1372-1385.

Essington, T.E., P.W. Sorenson, and D.G. Paron. 1998. High rate of redd superimposition by brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta)* in a Minnesota stream cannot be explained by habitat availability alone. Can. J. Fish Aquat. Sci. **55**: 2310-2316.

Foerster, R.E. 1968. The sockeye salmon, (*Oncorhynchus nerka*). Bulletin 162. Fisheries Research Board of Canada. Ottawa. P.145-150.

Fukushima, M. 1994. Spawning migration and redd construction of Sakhalin taimen, *Hucho perryi* (Salmonidae) on northern Hokkaido Island, Japan. J. Fish Biol. **44**: 877888.

Fukushima, M., T.J. Quinn, and W.W. Smoker. 1998. Estimation of eggs lost from superimposed pink salmon (*Oncorhynchus gorbuscha)* redds. Can. J. Fish Aquat. Sci. **55**: 618-625.

Fukushima, M. and W.W. Smoker. 1998. Spawning habitat segregation of sympatric sockeye and pink salmon. Trans. Am. Fish. Soc. 127:253-260.

Grost, R.T., Hubert, W.A., and Wesche, T.A. 1991. Description of brown trout redds in a mountain stream. Trans. Am. Fish. Soc. **120**: 582588.

Hawke, S.P. 1978. Stranded redds of quinnat salmon in the Mathias River, South Island, New Zealand. N.Z. J. Mar. Freshw. Res. **12**: 167171.

Hayes, J.W. 1987. Competition for spawning space between brown (*Salmo trutta*) and rainbow trout (*S. gairdneri*) in a lake inlet tributary, New Zealand. Can. J. Fish. Aquat. Sci. **44**: 4047.

Kitano, S., and Shimazaki, K. 1995. Spawning habitat and nest depth of female Dolly Varden *Salvelinus malma* of different body size. Fish. Sci. **61**: 776779.

Knapp, R.A., and Vredenburg, V.T. 1996. Spawning by California golden trout: characteristics of spawning fish, seasonal and daily timing, redd characteristics, and microhabitat preferences. Trans. Am. Fish. Soc. **125**: 519531.

Leonetti, F.E. 1996. Habitat attributes, sockeye salmon spawning behavior, and redd site characteristics at island beaches, Iliamna Lake, Alaska. M.Sc. thesis, University of Washington, Seattle.

McNeil, W.J. 1964. Redd superimposition and egg capacity of pink salmon spawning beds. J. Fish. Res. Board Can. **21**: 13851396.

McPhee, M.V., and Quinn, T.P. 1998. Factors affecting the duration of nest defense and reproductive lifespan of female sockeye salmon *Oncorhynchus nerka*. Environ. Biol. Fishes, **51**: 369375.

Montgomery, D.R., Buffington, J.M., Peterson, N.P., Schuett-Hames, D., and Quinn, T.P. 1996. Stream-bed scour, egg burial depths, and the influence of salmonid spawning on bed surface mobility and embryo survival. Can. J. Fish. Aquat. Sci. **53**: 10611070.

Peterson, N.P., and Quinn, T.P. 1996. Persistence of egg pocket architecture in redds of chum salmon, *Oncorhynchus keta*. Environ. Biol. Fishes. **46**: 243253.

Quinn, T.P. 1999. Variation in Pacific salmon reproductive behaviour associated with species, sex and levels of competition. Behaviour 136:179-204.

Quinn, T.P., and McPhee, M.V. 1998. Effects of senescence and density on the aggression of adult female sockeye salmon. J. Fish Biol. **52**: 12951300.

Schroder, Steven L. 1974-1976. Assessment of Production of Chum Salmon Fry From the Big Beef Creek Spawning Channel. Annual Report/Completion Report. Project No. AFC-67. University of Washington College Fisheries Research Institute.

Steen, R.P. and T.P. Quinn. 1999. Egg burial depth by sockeye salmon (*Oncorhynchus nerka*): implications for survival of embryos and natural selection on female body size. Can. J. Zool. Vol. **77**, 836-841.

Van den Berghe, E.P., and Gross, M.R. 1984. Female size and nest depth in coho salmon *(Oncorhynchus kisutch)*. Can. J. Fish. Aquat. Sci. **41**: 204206.

Young, M.K., Hubert, W.A., and Wesche, T.A. 1989. Substrate alteration by spawning brook trout in a southeastern Wyoming stream. Trans. Am. Fish. Soc. **118**: 379385.

Appendix C – Additional Information on the Effects of Domestication Selection on Fitness in Salmonids

Note: This is a new appendix, added since publication of the DSEIS. Text has not been redlined to provide for easier readability

Additional Information on the Effects of Domestication Selection on Fitness in Salmonids

Seattle Public Utilities

July 2005

Domestication selection results from the differences in selective pressures operating on heritable traits affecting the survival and reproductive success of salmon in the hatchery and natural environments. How these differences affect the reproductive potential of hatchery origin salmon in the natural environment has been the subject of ongoing research. Interpretation and application of research results is complicated by the variety in culture programs and species associated with hatcheries. Berejikian and Ford (2004) cite three main factors that are expected to influence the mean relative fitness of a hatchery population in the natural environment: 1) the origin of the hatchery population, 2) the number of generations the population has been propagated artificially and 3) the way in which the population has been propagated. Reisenbichler (in Nickum et al. 2004) stated "Incomplete knowledge clearly is one source of uncertainty. For example, data showing domestication or reduced (genetic) fitness of hatchery fish for natural production is limited and almost entirely from steelhead. More definitive modeling to quantify potential benefits and risk from supplementation will require data on heritabilities and rates of domestication in hatchery programs and associated loss of fitness for natural production, heritabilities and rates of naturalization (recovery of fitness with natural reproduction) and how these parameters vary among species, hatcheries and streams." Brannon et al. (2004) stated that, "Domestication, defined as the consequence of unintentional selection in hatcheries and referred to by Campton (1995) as natural selection in the hatchery environment, represents the most likely genotypic change that could occur in hatchery fish." Reisenbichler and Rubin (1999) found that "domestication selection is often intense". Some key challenges with domestication selection research are to sort out what differences are due to genetic change due to unintentional selection in the hatchery and what differences are due to hatchery management decisions or environmental causes (Brannon et al. 2004).

Recent Scientific Reviews

There have been two recent and substantive reviews examining the fitness of hatchery populations. Berejikian and Ford (2004) concluded that studies that included non-local stocks, domesticated stocks or captive, farmed stocks demonstrated highly reduced fitness. They revealed a low level of fitness relative to the wild population (<30%). Only one study was identified that evaluated hatchery effects on fitness using a local stock in the first generation and that was with steelhead, a species that was (and is typically) reared for an extended period. Here the authors of the study found relatively high fitness in hatchery returns and Berejikian and Ford indicated that it would be reasonable to assume >90% fitness relative to wild. The analysis of studies that included local stocks where the hatchery had operated for multiple generations was difficult "due to the lack of consistent results among studies and the lack of any studies of lifetime fitness'. Most of these studies evaluated steelhead and the author concluded that fitness under this scenario may not differ from the first scenario above for steelhead. They indicated that they could find no studies that estimated relative fitness of hatchery populations of species or life history forms that have a minimal freshwater rearing phase in a hatchery. They found it reasonable to assume that these populations would be less likely to change phenotypically and genetically by hatchery propagation than species with longer freshwater rearing times. Since no studies are similar to the Cedar River sockeye hatchery program, their review did not estimate

effects; however their comment about limited freshwater and hatchery residence time reducing likelihood of phenotypic and genetic change would appear relevant to the Cedar River Hatchery.

The Salmon Recovery Science Review Panel issued a report on the effects of hatchery returns on wild populations based on their meeting that was held on August 30-September 2, 2004. They reviewed literature on hatchery effects, focusing on studies that used local broodstock and excluding those where naturally spawning populations were comprised of a substantial number of hatchery returns. They concluded that there is a relationship between the loss of fitness and the number of generations in hatchery culture, based on studies conducted with steelhead, Atlantic salmon, and brown trout. They cited evidence in a steelhead study for a 10% reduction in fitness in the first generation of culture and noted that their analysis of a number of studies showed a decline in fitness of 20% per generation.

Hatchery Effects on Fitness

Much of the general hatchery effects research to date has focused on measurable characteristics associated with reproduction, including behavior, morphology, age at maturity and survival rates. Hatcheries can alter growth rates in salmon and growth is associated with changes in parameters that affect fitness. A challenge of research in this area is determining whether such changes are the result of genetic change or reflect the altered environment of the hatchery. Whether or not a hatchery will cause genetic changes that result in reduced female body size is an important question because most research suggests that body size is positively correlated with characteristics that are important to fitness. Forbes and Petermann (1994) provide a summary of some of the literature on the effects of body size on reproduction and provide the following analysis: (references are omitted for brevity, but may be found in the publication):

"In Pacific salmon, larger females produce more and larger eggs on average than small females, a phenomenon most closely studied in coho salmon. In female coho, fecundity increases more slowly than female mass with increasing length (larger females produce fewer eggs/unit body mass than small females), but total egg mass (e.g. number X biomass/egg) increases faster than female mass. The same pattern holds for other Pacific salmon. Thus larger female salmon, with fewer eggs per unit biomass, apparently sacrifice fecundity for increased egg size compared with small salmon …" They also noted "that smaller eggs have lower metabolic requirements and are more likely to survive incubation in low-quality gravel than large eggs" and conclude that large egg size therefore bears an evolutionary cost in environments with low-quality gravel". They explained that the potential disadvantage of large egg size may be offset to some degree by the frequency that large eggs are deposited in high quality gravel and the production of larger fry. Forbes and Petermann (1994) provided three theories for why egg size increases with female body size, but noted that as of 1994, there was no adequate measure of survivorship of offspring from females of different size. They note that the importance of body size may be mediated by density; at lower densities there is less intraspecific competition and therefore there is less advantage to body size of females. Van den Berghe and Gross (1989) found that body size contributed to adult female coho fitness in three ways: through increased initial biomass of egg production,

the ability to acquire a high-quality territory for egg development, and success in nest defense. These factors resulted in up to a 23-fold fitness advantage to the largest females. On the other hand, Holtby and Healey (1986) concluded that there was no consistent advantage to large size for coho in Carnation Creek, British Columbia. They found no consistent advantage for large size in egg to fry survival and smolt to adult survival.

A number of published studies and reports have compared female size in hatchery returns with those of natural origin of the same age. The tendency for hatchery returns to be smaller at age of maturity has been observed in coho (Fleming and Gross 1989, Quinn et al. 2004). Bumgarner et al. (1994, cited in Gallinat, 2004) found that size-at-age was smaller for F_1 (first generation) hatchery Chinook returns to the Tucannon River compared to natural origin returns. However, a later report for this project by Gallinat (2004) reported no significant difference in mean length between natural and hatchery origin Chinook returns when all years were combined, including the early years referred to in Bumgarner et al. (1994). Not all studies have found significant differences in female size based on hatchery and natural origin. Heath (2003) reported no trend in body size over a twenty-year period in four Chinook hatchery populations in British Columbia. Quinn et al. (2004) found no decline in size at age for hatchery Chinook, but noted a decline in average size due to earlier age of maturity, resulting from the tendency to release progressively larger smolts.

Female Size at Age in the Cedar River

A recent report evaluating returns to the interim sockeye hatchery on the Cedar River, found that in ten size comparisons between hatchery and natural origin female adult sockeye that spawned in the Cedar River between 1997-2000, five were statistically significant, where hatchery females were smaller than natural origin returns (Fresh et al. 2003). In comparisons using female sockeye collected at the broodstock weir, five of six comparisons of female size showed significantly smaller size in those of hatchery origin. Two alternative hypotheses for size differences were presented in the report, but the authors acknowledged that the cause of these differences between females of hatchery and natural origin is unknown. One of the proposed theories cites a linkage between natural selection for larger females spawning in the river and presumes that these females would then produce larger progeny that would return as larger adults. Under this theory, smaller females would be at a survival disadvantage in the river. Under this theory, the hatchery environment removes the relative selection advantage of larger females and provides a protective environment for females of all sizes, resulting in a reduction in mean size of the hatchery progeny. However, Helle (1989) reported no tendency for large parents to produce large, mature offspring in his study of chum salmon and attributed the variability in progeny size to marine environmental conditions during the last season at sea.

The other theory offered in Fresh et al. (2003) to explain size differences suggests that they may be an artifact of differences in fry entry timing into Lake Washington because hatchery fry enter earlier than natural fry on average. For hatchery releases in 2004, early entry fry grew to a larger size in Lake Washington than middle and late fry (Schroder, 2005A). There is some evidence in Atlantic salmon that a negative relationship exists between presmolt and post smolt growth rates (Einum et al. 2002).

If the underlying cause for size differences between hatchery and natural origin returns is fry entry timing, these differences are expected to be substantially reduced or eliminated with the replacement hatchery because it will have equipment that is capable of modifying incubation temperatures with river temperatures.

Body Size and Redd Depth

The consequences of body size on reproduction have been studied. Quinn (2005) compiled information from a number of studies on various species of salmonids that demonstrated a general relationship of increasing redd depth with body size. Steen and Quinn (1999) provided redd depth data for sockeye. Van den Berghe and Gross (1984) found that larger coho dug deeper nests and describes the selective advantage that deeper redds have by providing better protection to eggs from flood scour and dig up by other spawning salmon Larger females are thought to be able to secure better redd sites and to defend their nest sites longer as well. Holtby and Healey (1986) found that when body size (expressed through corresponding assumptions about redd depth) was included in a model used to predict egg to fry survival for coho, the predictive ability of the model worsened. They concluded that scour and gravel quality, not body size, were the most important variables in the model. They suggested that spawning ground competition and high scour favor larger females while poor gravel quality favors small female size. Thus, optimal body size is the result of specific conditions for a given river or reach. They predict that good gravel quality, low competition and shallow scour are relatively neutral to female size. Schroder et al. (2005) found that the largest females produced the largest number of fry and that this was due to higher fecundity in larger females; when fecundity was factored in, the authors found no difference in the capacity of fish of various sizes to produce fry from eggs. They cautioned, however, that these results were produced in an artificial channel and may not apply to natural spawning conditions.

Egg size, Fecundity and Egg Biomass

Comparisons of hatchery and natural origin salmon have sometimes resulted in differences in egg size, fecundity or total egg biomass. In a study of the University of Washington hatchery program over 3 to 5 decades, reproductive investment in terms of gonad size adjusted for body size, decreased for coho but not for Chinook (Quinn et al. 2004). Size- adjusted fecundity was influenced by marine growth for coho and Age 3 Chinook salmon, suggesting that egg size is determined later in life. Heath et al. (2003) found a significant reduction in egg size in hatchery Chinook in systems with high levels of supplementation (28 and 43%), but not in those with lower levels of supplementation (4 and 16%). They stated that hatcheries drive exceptionally rapid evolution in egg size and that this effect is proportional to the level of hatchery supplementation of a population. However, the results reported by Quinn et al. (2004) were not consistent with this hypothesis. Gallinat (2004) reported that egg size was larger in hatchery origin Chinook females of the same age (statistically significant for Age 4, but not for Age 5). In this report, fecundity was significantly greater for natural origin returns of the same age compared to hatchery origin returns. No clear pattern with respect to hatchery effects on egg size has emerged from the literature; however it is known that hatcheries can affect growth and that growth affects egg size. It is therefore difficult to sort out the effects due to genetic change.

Selection for egg size during incubation has also been investigated. Several investigators have presumed that large eggs are subject to higher mortality under low oxygen conditions due to the assumption that smaller eggs have lower metabolic requirements (van den Berghe and Gross 1989, Holtby and Healey 1986, Sargent et al. (1987). However, Einum et al. (2002) refuted the hypothesis that "bigger is worse during incubation" that is based on the assumption that oxygen requirements increase in proportion to egg volume or mass. Their study with brown trout demonstrated that survival of larger eggs was equal to that of small eggs at high oxygen levels, but survived better than smaller eggs when exposed to low oxygen levels. Generally hatcheries maintain oxygen levels above those used in the investigation by Einum et al. (2002), which may avoid favoring eggs, large or small. Beacham and Murray (1985) found that incubation survival was highest for eggs from small females and lowest for eggs from large females over a range of incubation temperatures.

Effects of Body Size on Reproductive Traits in Cedar River Sockeye

Quinn et al (1995) found that body length in Cedar River sockeye was positively correlated with gonad weight, egg number, egg weight, snout length and hump size and that these measures were correlated with each other. They found that individuals that had greater development of a particular trait also had greater development of the other traits. Egg size and egg number were inversely correlated for a given body size in Cedar River sockeye.

Size of Fry

Helle (1989), Forbes and Petermann (1994) and Beacham and Murray (1985) cited studies that show that larger eggs produce larger alevins or fry. Beacham and Murray (1985) found that the relationship between egg weight and alevin size was dependent on incubation temperature. In some cases larger fry are correlated with faster growth rates between the fry and smolt stage. Forbes and Petermann state that there are several "absolute" benefits of larger size: " larger fry are (i) more resistant to starvation, (ii) better at avoiding predators, and (iii) reach threshold sizes where they are not vulnerable to certain gape-limited predators more quickly than smaller fry, resulting in lower juvenile mortality…" West and Larkin (1987) found that larger sockeye fry tended to exhibit higher growth rates and leave the lake as larger smolts. Not all scientists are convinced that larger fry have survival advantages to the smolt stage. Helle (1989) concludes that "parental size and age, and egg size had little or no effect on fry growth rate or early mortality" and that "the relationship between egg size and smolt size in salmonids is not clear…" Quinn (2005) discussed the influence of fry size, timing and other factors on subsequent growth rate, territoriality and survival.

Reproductive Behavior

Reproductive behavior prior, during and following spawning is important to reproductive success. Fleming and Gross (1992) cite the importance of aggressive behavior in determining the ability to acquire and defend nesting territories for females and mates for males; the importance of complex courting and spawning behavior patterns for successful oviposition and fertilization; the effects of delay in the onset of breeding and extended breeding periods that can reduce the female's ability to successfully deposit her eggs before she dies; and female nest guarding to prevent egg loss through nest destruction by other females attempting to use the same site. Because salmon are subject to very different processes when bred in a hatchery, studies have been done to better understand how the absence of natural process affects the reproductive behavior, physical characteristics and success of the progeny of hatchery returns when they spawn. Fleming and Gross (1992, 1993) found that hatchery origin coho males were less aggressive during spawning in an experimental stream compared to a different stock of natural origin coho. Consequently, these males engaged in fewer spawnings than the natural origin fish. In the same study, hatchery females were as aggressive as natural origin females, but had higher retention of eggs, were more prone to delay in the onset of breeding and lost more eggs to nest destruction by other females. They found that the reproductive success of hatchery females was independent of size while that of natural origin females was strongly dependent on size. Competition, created through higher spawning density, appeared to have more impact on the spawning effectiveness of hatchery males than on hatchery females. In a study of spring Chinook by Schroder et al. (2005), they found that hatchery origin females were as competent in reproductive success as natural origin females at lower spawning density. At higher densities, wild females had a survival advantage that ranged from 1.9-11.7% over hatchery origin females. In the same study, hatchery origin males did not produce as many progeny as natural origin males.

Fleming and Gross (1989) suggested that female competition on the spawning grounds can generate strong natural selection on coho salmon. They found a correlation between the expression of secondary sexual characteristics (body coloration, length of snout) and higher levels of breeding competition. They suggest that these changes in body shape are genetically based as they tend to appear before competition for spawning sites begins.

Age at Return

Gallinat (2004) found that hatchery returns matured at a younger age than natural origin returns of Chinook to the Tucannon River. They attributed this difference to the larger size at release for the hatchery smolts. Fresh et al. (2003) found no difference in age at return for sockeye returning to the Cedar River based on hatchery or natural origin.

Smolt to Adult Survival

Gallinat (2004) found that smolt to adult survival rates for wild origin Chinook returns were 3 times higher than for hatchery origin returns. They also found that adult to adult survival was about 4 times greater for hatchery returns than wild returns. Blouin and Araki (2004) evaluated the relative fitness of two hatchery steelhead stocks against wild stock, where one hatchery stock was an out of basin stock with a long history of hatchery production and the other was local, following a conservation hatchery approach. The relative fitness for the old hatchery stock was very low relative to wild stock, 0.11 and 0.098, for males and females, respectively. The conservation-stock hatchery fish had higher, but more variable relative fitness (0.63-1.21). They noted that parentage from many of the returns could not be established, particularly for fathers, and concluded that this might have been the result of resident trout spawning with steelhead. The interaction between resident and anadromous forms of *O. mykiss* adds complexity in the evaluation of hatchery effects in this species.

Cedar River Fry to Smolt Survival

Schroder (2005A) examined data from sockeye smolts collected in Lake Washington in 2004. While these data should not be considered representative for all years because of the limited data base, nor should they be considered necessarily predictive of results from the replacement hatchery, the results for the 2004 outmigrant smolts showed that time of entry into the lake affected survival to smolt stage in some cases, as did short term rearing. Middle to late unfed sockeye fry survived better than early entry fry from the hatchery. Analysis of adults sampled from 2004 suggested that later fry releases from the hatchery survived at higher rates compared to early and middle release groups (Schroder 2005B). As noted above, the overall entry timing difference between hatchery and natural fry is expected to be significantly reduced or eliminated with the replacement hatchery and would be expected to influence survival rates. For the 2004 smolts, short term holding and feeding resulted in equivalent survival of hatchery fry with that of naturally produced fry; releasing unfed hatchery fry resulted in lower survival rate (about 11% lower) from fry to smolt compared to that of natural fry.

More on Effects of Body Size

Helle (1989) found that survival of progeny was positively correlated with the mean length of the parents in chum salmon across brood years. The difference was greater than could be explained by higher fecundity of the larger females. Helle suggests that higher survival could have been due to the ability of females to utilize more favorable nest sites or larger egg size. Hankin and McKelvey (1985) found that total fecundity, total ovary weight and mean egg weight were all strongly correlated with fish length and suggested that selection pressures may be positive for both egg weight and total fecundity. They suggest that the significant trend towards increased egg weight with fish length suggests that egg size may be an important survival characteristic in Klamath River Chinook.

Selective forces on reproductive fitness are complex and hatchery effects add to that complexity. Through changes in age at maturity, size at age the returns, spawn timing

hatcheries among others, hatcheries have the potential to affect egg size, fecundity, duration of parental care, nest site selection, expression of secondary sexual characteristics, intra- and inter- specific competition, protection of eggs from scour, incubation survival, fry to smolt survival. As can be seen above, the literature on the effects of hatcheries on these parameters is sometimes contradictory, but demonstrates that characteristics associated with fitness have occurred in some populations.

Domestication selection appears to be the most likely mechanism to effect genetic change. The risks and magnitude of hatchery effects are thought to be somewhat proportionate to the time spent in the artificial environment and the number of generations that a stock has been isolated in the hatchery. Assessments of hatchery impacts on fitness have not included programs as that being implemented for the Cedar River in terms of key factors thought to affect fitness: local stock, broodstock collection protocol, breeding protocol, release of fry soon after emergence, rate of naturalization and species. The existing literature focuses mostly on programs using hatchery stocks of steelhead, coho and Chinook using extended freshwater rearing. With few exceptions, where fitness has been measured in these programs there has generally been a decline in fitness, with substantial variability among various assessments. Reisenbichler and Rubin (1999) reviewed several studies and concluded that substantial change in fitness results from traditional artificial propagation of anadromous salmonids held in captivity for one-quarter or more of their life. They noted that "To date almost no comparable data are available for species or populations that are held in captivity for shorter portions of their life: …[including] some sockeye populations." It is apparent from the literature that there is a need for further research into the effectiveness of various hatchery reform measures and to assess fitness in programs such as that being proposed for the Cedar River sockeye.

Even though the literature has not dealt directly with programs like that being proposed in the Cedar River, the literature is helpful in identifying what monitoring is needed and in establishing factors that influence fitness. For example, there is evidence that the potential for genetic and phenotypic change is proportional to time spent in the hatchery. There is additional evidence that the use of local stock results in higher fitness in hatchery releases. Genetic principles suggest that random breeding and high male to female spawning ratios will help to avoid genetic change. The Cedar River sockeye culture strategy has been developed with the benefit of this knowledge and has considered how to incorporate approaches that are thought to minimize the risk of genetic effects. Nevertheless, it is not possible to eliminate such risks. Thus, the question of how unavoidable domestication selection will affect fitness will need to be addressed through evaluation guided by the adaptive management plan. The potential consequences, case-specific variability in hatchery practices, species and environmental factors and the limited understanding of the effects of naturalization underscore the importance of monitoring and being responsive to information, as it becomes available.

References

Beacham, T.D., and C.B. Murray. 1985. Effect of Female Size, Egg Size, and Water Temperature on Developmental Biology of Chum Salmon (Oncoryhnchus keta) from the Nitinat River, British Columbia , Canadian Journal of Fisheries and Aquatic Sciences. 42:1755-1765.

Berejikian, B.A. and M.J. Ford. 2004. Review of relative fitness of hatchery and natural salmon. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-61, 28p.

Blouin, M. 2003. Relative reproductive success of hatchery and wild steelhead in the Hood River. Final report on work conducted under BPA Intergovernmental Contract 9245, Project No. 1988-053-12 and ODFW Interagency Agreement No. 001-2007s. Department of Zoology, Oregon State University, Corvallis, Oregon. 01 May 2003.

Blouin, Michael and Hitoshi Araki. 2004. Reproductive Success – Steelhead in the Hood River 2003-2004 Annual Report, Project No. 200305400. 12 electronic pages. BPA Report DOE/BP-00015883-1.

Brannon, E., D. Amend, M. Cronin, J. Lannan, S. LaPatra, W. McNeil, R. Noble, C. Smith, A. Talbot, G. Wedemeyer, and H. Westers. 2004. The controversy about salmon hatcheries. Fisheries 29(9):12-31.

Bumgarner , J.D., G. Mendel, L. Ross, D. Milks, J. Ded;pff/ 1994. Lover Snake River Compensation Plan Tucannon River Spring Chinook Salmon Hatchery Evaluation Program 1993 Annual Report to U.S. Fish and Wildlife Service, Afffl/LSRR-94-09, Cooperative Agreement 14-16-0001-93539. Washington Department of Fish and Wildlife, Olympia, Washington.

Campton, D. E. 1995. Genetic effects of hatchery fish on wild populations of Pacific salmon and steelhead: what do we really know? Pages 337-353 in H. Schramm, Jr. and R. G. Piper, editors. Uses and effect of cultured fishes in aquatic ecosystems. American Fisheries Society, Symposium 15, Bethesda, MD.

Einum, S, Hendry, A.P. and Fleming, I.A. 2002A. Egg-size evolution in aquatic environments: does oxygen availability constrain size? Proceedings of the Royal Society, London B 269:2325-2330

Einum, S, Thorstad, E.B. and Naesje, T.F. 2002B. Growth rate correlations across life-stages in female Atlantic salmon, Journal of Fish Biology, 60:780-784.

Fleming, I.A. and Gross, M.R. 1989 Evolution of Adult Female Life History and Morphology in a Pacific Salmon (Coho: Oncoryhnchus kisutch). Evolution 43:141-157.

Fleming, I.A. and Gross, M.R. 1992 Reproductive behavior of hatchery and wild coho salmon (Oncorhynchus kisutch): does it differ?, Aquaculture, 103:101-121.

Fleming, I.A. and Gross, M.R. 1993 Breeding Success of Hatchery and Wild Coho Salmon (Oncorhynchus kisutch) in competition, Ecological Applications, 3:230-245.

Forbes. L.S., and RM. Petermann 1994. Simple size-structured models of recruitment and harvest in Pacific salmon (Oncorhynchus spp.). Canadian Journal of Fisheries and Aquatic Sciences 51: 603-616.

Fresh, K.L., SI. Schroder, E.C. Volk, L Grimm, and M. Mizell. 2003. Evaluation of the Cedar River sockeye salmon hatchery: analysis of adult otolith recoveries. Washington Department of Fish and Wildlife, Olympia, WA.

Gallinat, M.P. 2004. Tucannon River Spring Chinook Salmon Hatchery Evaluation Program. 2003 Annual Report. Washington Department of Fish and Wildlife, Olympia, WA

Hankin, D.G, and McKelvey, R. 1985 Comment on Fecundity of Chinook Salmon and its Relevance to Life History Theory Canadian Journal of Fisheries and Aquatic Sciences 42: 393-395

Heath, D.D., J.W. Heath, C.A. Bryden, R.M. Johnson, and C.W. Fox. 2003. Rapid evolution of egg size in captive salmon. Science (299):1738-l740..

Helle, JR 1989. Relation between size-at-maturity and survival of progeny in chum salmon, Oncorhynchus keta (Walbaum). Journal of Fish Biology 35(Supplement A):99-107.

Holtby, L. B. & Healey, M. C. 1986 Selection for adult size in female coho salmon (Oncorhynchus kisutch). Can. J. Fish. Aquat. Sci. 43, 1946–1959.

Nickum, N.J., P. M. Mazik, J. G. Nickum, and D. D. MacKinlay, editors. 2004. Propagated fish in resource management . American Fisheries Society, Symposium 44, Amercian Fisheries Society, Bethesda, Maryland.

Quinn T.P. 2005. The behavior and ecology of Pacific salmon and trout. U. of Washington Press. 378 p.

Quinn, T.P. Hendry, and L.A. Wetzel. 1995. The influence of life history trade-offs and the size of incubation gravels on egg size variation in sockeye salmon (Oncorhynchus nerka). Oikos (74):425-438.

Quinn, T.P., Vollestad, L.A., Peterson, J. and Gallucci, V. 2004. Influences of freshwater and marine growth on the egg size-egg number tradeoff in coho and Chinook salmon. Transactions of the American Fisheries Society 133:55-65

Reisenbichler R.R. and Rubin, S.P., 1999. Genetic changes from artificial propagation of Pacific Salmon affect the productivity and viability of supplemented populations. ICES Journal of Marine Science 56:459-466.

Salmon Recovery Science Review Panel 2004 Report for the meeting held August 30-September 2, 2004 National Marine Fisheries Service, Seattle, WA

Sargent, R. C., Taylor, P. D. & Gross, M. R. 1987 Parental care and the evolution of egg size in fishes. Am. Nat. 129, 32–46.

Schroder, S. 2005A. Results of Otolith Decodes performed on sockeye smolts collected in Lake Union in May of 2004. Washington Department of Fish and Wildlife. Memo to Anadromous Fish Committee, March 2, 2005. 10 p.

Schroder, S. 2005B. Results of Otolith Decodes performed on adult sockeye caught by sports gear in 2004. Washington Department of Fish and Wildlife. Olympia, WA. Memo to Anadromous Fish Committee, March 2, 2005. 6 p.

Schroder, S.L., Knudsen, C.M., Pearsons, T.N., Fast, D.E., and Watson B.D. 2005. Comparing the Reproductive Success of Yakima River Hatchery- and Wild-origin Spring Chinook. Yakima/Klickitat Fisheries Project Monitoring and Evaluation Annual Report 2004 Prepared for U.S. Department of Energy. Portland, Oregon.

Steen, R.P. and Quinn, T.P. 1999 Egg Burial depth by sockeye salmon (Oncorhynchus nerka): implications for survival of embryos and natural selection on female body size. Canadian Journal of Zoology 77(5): 836-841. Need to get

Van den Berghe, E.P., and M.R. Gross. 1984. Female size and nest depth in coho salmon (Oncorhynchus kisutch). Canadian Journal of Fisheries and Aquatic Sciences 41:204-206.

Van den Berghe, E.P., and M.R. Gross. 1989. Natural selection resulting from femalebreeding competition in a Pacific salmon (coho: Oncorhynchus kisutch). Evolution 43:125-140.

West, C.J., and Larkin, P.A, 1987. Evidence for size –selective mortality of juvenile sockeye salmon (Oncorhynchus nerka) in Babine Lake, British Columbia Canadian Journal of Fisheries and Aquatic Sciences 44:712-721

Part II – Comment Letters and Responses
Public Hearing Transcript and Responses

Part II of this FSEIS contains comments received on the DSEIS and responses to those comments. The comments have been reduced to allow two pages to be reproduced onto one page. Provided first are several general responses to address issues raised by several commenters, followed by individual comments and responses to those comments.

Comment Letter Index

(in order of appearance)

NO	NOAA
FW	WDFW
TT	Toby Thaler/Roz Glasser
PE	People for Puget Sound
SC	Sierra Club
TU	Washington Council of Trout Unlimited: Frank Urabeck and Mark Taylor
BR	Bill Robinson
SW	Sam Wright
TB	Thomas Buehrens
CB	Coleman Byrne
CD	CaptDarlin@aol.com
TC	Talibah Chiku
VG	Victor Garcia
RG	Roz Glasser
JL	John Lombard
NM	Nancy Muller
SN	Sue Nattinger
GN	Gail Nicolls
MN	Martin Norris
RN	Rachel Norris
PO	Paul Olson
AR	Adrienne Ross
JS	James Scanlan
JE	Jeff Stern
SS	Sstewart286@aol.com
SU	John Sullivan
JI	Jim Switt
RW	Robert Wissmar
GR	Green River Steelhead Trout Club
KC	King County Outdoor Sports Council
MT	Northwest Marine Trade Association
MV	Greater Maple Valley-Black Diamond Chamber of Commerce
AB	Alan Barrie
AD	Allan Dusty Routh
AT	Aaron Thress and Denise Sherman
BB	Bill Brown
BF	Buford Fearing
BL	Bob Lawson
BP	Barbara and Stan Pasin
CC	Carl and Irene Carver
CF1	Unsigned Comment Form
CF2	Unsigned Comment Form
CH	Chris Davis

DB	David Bergeron
DC	Dave Croonquist
DI	Dick Colman
DP	Donald Peterson
DS	Doug Smith
DV	Don Van Parys
GL	Ginny, Mike, and Bob Lodwig
GM	Gary McGrew
GO	GO1SALMON@aol.com
GP	Gayle Powell
JG	James Guess
JJ	Jim, Jill, and Cassie Guess
JK	John Kelly
JM	Jack Metcalf
JO	John Snyder
JR	Jay Rusling
JW	John Williamson)
KF	Ken Fortune
KM	Kelli Mack
LA	Laurie Abbey
LE	Lisa Eckhart
LL	Gina Lull
LU	Brian Lull
LW	Larry Walsh
MA	Joseph Madrano
MC	Greg McPherson
MK	Martin Kasischke
ML	Mike Lindbo
MM	Maurice Munch
MS	Michael Sipin
PF	Pfeiflemc@aol.com
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PL	Phil Lyons
PW	David Powell
RA	Robert Abbey
RC	Ray Colby
RD	Rory Diessner
RE	Richard Elliott
RH	Russ Heagle
RK	Rich Kato
RY	Ray Ashmun
SA	Sherif Awad
ST	Mike Stefanick
TJ	Tim Johnson
TL	Tom LaPlant
WR	Jim Wright
TR	Public Hearing Transcript

General Responses to Comments

Seattle Public Utilities (SPU) received a number of comments on the DSEIS that raised common issues regarding the scope of the SEIS, previous environmental review, legal or policy considerations, studies and data and others. The following general responses address these issues. More specific responses to individual comments are provided following these general responses.

General Response No. 1: Comments Outside the Scope of the SEIS

Issue: Several commenters raised issues related to previous environmental review, or to policy or legal issues that are outside the scope of the SEIS. Seattle Public Utilities prepared the SEIS specifically to respond to the Hearing Examiner's decision and, accordingly, the SEIS focuses on the issues the Hearing Examiner directed SPU to address, namely the worst case analyses for specific potential impacts and the Adaptive Management Plan (AMP). For example, some comments question the assumptions underlying the Cedar River Habitat Conservation Plan EA/EIS; some urge a re-examination of alternatives to the replacement hatchery project itself, questioning the wisdom of the policy choice made by the Parties to the Landsburg Mitigation Agreement (LMA) or the merits of the LMA. Other commenters raised various legal arguments. In some cases commenters questioned other impacts previously examined and not included in the Hearing Examiner's direction, such as overall river ecology or impacts related to IHN. In many cases, these comments reflect earlier comments SPU received and responded to as part of either the final Cedar River Habitat Conservation Plan (HCP) EA/EIS or the Cedar River Hatchery FEIS.

Response: For purposes of this SEIS, SPU is providing substantive responses to all comments directly related to the worst case analyses and the AMP. The scope of SPU's response to comments on the SEIS is consistent with the decision of the Hearing Examiner:

> *"Prior to hearing, the Examiner dismissed the issue of whether the FEIS was inadequate because it did not include a non-hatchery alternative, because this issue went to the adequacy of the programmatic EA/EIS, rather than the project FEIS. The appellant's appeal and closing statement appear to continue to raise this argument. Again, the programmatic EA/EIS cannot be challenged through an appeal of this project-level FEIS, and these arguments cannot be considered. Similarly, the issue whether the City has erred in presuming that it is legally committed to building the proposed hatchery is not before the Examiner."*

(Hearing Examiner Decision, Conclusions, ¶ 3)

> *"The issues that remain in this appeal concern the adequacy of the FEIS with respect to disclosure of certain impacts, and identification of mitigation measures. Some of the appellant's arguments and evidence challenge directly the wisdom of the proposal itself, but that is beyond the scope of this appeal and those arguments are not considered."*

(Hearing Examiner Decision, Conclusions, ¶ 4)

The 2003 Cedar River Hatchery FEIS focused on project-specific impacts and included new information that had become available since completion of the Cedar River HCP EA/EIS. See the FEIS, p. 1-8 and Section 2.4. The SEIS does not assume that decision-makers will go forward with the hatchery project; instead, the results of the SEIS process will provide useful information to the public and decision-makers, as they consider further decisions relating to the construction and operation of the replacement hatchery.

General Response No. 2: Use of Background Data in Preparing the SEIS, Adaptive Management Plan and the Worst Case Analyses.

Issue: Several commenters raised concerns about how data from interim hatchery operations and other relevant studies have been incorporated into the worst case analyses and the development of the AMP. They suggested that no summary of data over a 10 to 12 year period had been produced and that available information had not been used in SEIS analyses or that the City was biased in its use of information. Specific comments were received concerning the Lake Washington Studies indicating that commenters thought that one of the goals of these studies was to assess effects of the interim sockeye hatchery. Some commenters indicated that the interim sockeye hatchery program has been an adaptive management experiment and that results should be available for evaluation of potential adverse effects on wild fish of the replacement hatchery.

Response: Development of worst case analyses and the AMP considered available information from many sources, including data collected to manage sockeye and Chinook populations, research concerning the ecology of sockeye in the Lake Washington system and their relationships with other species and results of the interim hatchery. Relevant information has been used to identify where potential adverse effects could occur and to evaluate them to the extent that available information allows. Where uncertainty exists, this information was used along with relevant information from other systems to aid the development of worst case analyses. The following sections describe some specific sources of information and how they have been used.

Lake Washington Studies: The purpose of the Lake Washington Studies was to evaluate the potential factors contributing to poor sockeye survival in Lake Washington (p. 2.33, HCP), not to evaluate hatchery effects on naturally reproducing sockeye or effects on other species. The studies were multi-agency efforts funded by the Lake Washington Forum, an aggregation of local jurisdictions managed by King County, to study factors that may have contributed to the declining numbers of sockeye returning to the Lake Washington system. The studies were led by Kurt Fresh, then at Washington Department of Fish and Wildlife (WDFW). The studies initially focused on six study questions:

- Food limitations: carrying capacity of Lake Washington for sockeye;
- Early lake life of sockeye fry near the mouth of the Cedar River;
- Changes in predator distribution and diet;
- Predation on juvenile sockeye during lake residence;
- In-lake ecology of sockeye salmon originating from Bear and Issaquah creeks; and
- Mortality of Cedar River sockeye salmon fry during their downstream migration.

(Source: February 16, 1993 memo from Kurt Fresh, Department of Fisheries, State of Washington)

Relevant information on predation, sockeye fry production, food supply and species interactions resulting from the Lake Washington Studies and other sources has been utilized by SPU and others involved in developing the HCP, HCP EA/EIS, FEIS and SEIS, and in the design of the replacement hatchery facilities. While no agency has compiled and summarized all of the work of the Lake Washington Studies into a single report, many of the results have been incorporated into reports or publications. Study findings have been presented through public workshops. Kurt Fresh, now with NOAA Fisheries, led public workshops on December 14, 1999, and June 6, 2000, to distribute findings to scientists, elected officials and the public. A final workshop was held in late 2002 where investigators presented their findings and Kurt provided his summary of what was learned.

Seattle Public Utilities has reviewed reports and data summaries from this work and applied the relevant results to its analyses. Reference information is identified in the list of references in worst case analysis workshop summaries, the AMP, the FEIS and the SEIS. Examples of information sources that have been used include:

- Sockeye fry production estimates from the Cedar River and Bear Creek;
- Predation losses in the Cedar River as a function of instream flow;
- Evaluation of the adequacy of food supply in Lake Washington; and
- Predation of sockeye in Lake Washington.

The original study questions of the Lake Washington Studies evolved over time as new questions arose. For example, evaluation of the effects of the Chittenden Locks on passage of juveniles and adults was included, and this led to improvements in facilities and operations. Additional emphasis was placed on the monitoring and evaluation of Chinook salmon in Lake Washington and included evaluation of interactions with sockeye. Increased interest on the effects of hatcheries on naturally spawning populations also brought about changes in the focus of salmon research. The results of the Lake Washington Studies along with additional information from other studies in the Lake Washington Basin have led to the identification of key areas of uncertainty in the AMP, and these reflect current areas of uncertainty with respect to potential adverse effects of the sockeye hatchery program. Information from the research that has been conducted to date is included in the description of existing data and knowledge associated with each area of uncertainty. Information from Lake Washington Studies and other monitoring and research has been used in developing the worst case analysis. Examples include (see cited references in text for information sources):

- Presmolt sockeye information;
- Detailed assessment of spring food supply;
- Chinook redd survey and superimposition information;
- Size comparisons between hatchery and natural origin sockeye;
- Straying results to Bear Creek;
- Juvenile Chinook production data from the Cedar River;
- Genetic studies of sockeye in the Lake Washington basin;
- Cutthroat and northern pikeminnow predation on sockeye in Lake Washington;
- Adult return timing information for hatchery and natural origin sockeye;
- Age at return information for hatchery and natural origin sockeye;

- Sockeye spawner distribution information for hatchery and natural origin sockeye; and
- Sockeye fry outmigrant timing information for hatchery and natural origin sockeye.

Seattle Public Utilities has sought to incorporate relevant and reliable information from many sources into the SEIS and AMP and has not suppressed or withheld information as some commenters have suggested. The application of results of the interim hatchery to the evaluation of effects of the replacement hatchery has been carefully considered, and some commenters have expressed that SPU should indicate that such effects are certain to occur. Based on existing information and the evaluations done to date, including the worst case analysis and AMP, SPU believes that the extent to which interim hatchery operations are predictive of the replacement hatchery varies; therefore, they have been evaluated on a case by case basis.

General Response No. 3: The Worst Case Analysis Process

Issue: In response to the Hearing Examiner's decision, the scope of the SEIS specifically included discussion of potential "worst case" impacts that the proposed replacement hatchery could have relative to genetics, predation, competition for food, competition for spawning sites and superimposition. These "worst case" analyses were developed through workshop discussions with invited scientists. Some commenters raised questions and concerns about the process used to conduct the worst case analysis.

Response: Seattle Public Utilities looked for models or templates to use in the worst case analysis but found little case law or previous examples for worst case analyses prepared under State Environmental Policy Act (SEPA) or the National Environmental Policy Act (NEPA). Seattle Public Utilities developed a worst case methodology that reasonably addressed the issues raised in the Hearing Examiner's decision.

The worst case analysis was carried out using a series of three workshops running concurrently over the course of a day. Worst case workshop participants included scientists with significant expertise in the specific disciplines needed to address the issues identified in the Hearing Examiner's decision. Scientists involved in the workshop were invited because they are knowledgeable about the issues and capable of applying professional judgement to difficult questions. This expertise included familiarity with issues associated with specific disciplines (genetics, predation, competition and superimposition). Most were familiar with the Cedar River and Lake Washington system, but some value was attached to including those with experience elsewhere. All of the participants were from public resource agencies or universities, including the University of Washington and University of Idaho, as well as the WDFW, U.S. Fish and Wildlife Service (USFWS), NOAA Fisheries (National Marine Fisheries Service), U.S. Geological Survey, and King County.

Seattle Public Utilities initially identified potential experts for each panel, and discussed this list with several of the scientists who had previously advised SPU regarding issues relating to the hatchery, with scientists who were knowledgeable in the subject areas to be discussed, and with agencies who might suggest additional participants to ensure that a full range of expertise would be represented. Panelists included those who were considered to be regional or national experts, and many had published in the subject area under discussion. The panels purposely included

scientists who would represent different perspectives to encourage scientific discussion. The technical leads for the workshop were given the final say in the selection of the panelists.

Seattle Public Utilities extended invitations to the participants approximately four weeks prior to the workshop. All invitees agreed to participate; one of the participants subsequently arranged for an alternate of his choosing without consulting SPU or the technical leads. Approximately one week prior to the workshop, relevant information (background studies, data, etc.) as determined by the lead scientists was posted on the SPU website to allow participants to become familiar with background information on the project. The participants provided additional information at the workshop. A list of these materials is available upon request from SPU.

The workshop formats were structured to encourage questions and discussion among the participating scientists about the worst case analysis for each area of uncertainty identified by the Hearing Examiner as requiring further evaluation. Seattle Public Utilities staff facilitated these discussions. A set of "worst case assumptions" was provided to the workshop participants. Each group could add to or alter those assumptions, as they deemed appropriate, as long as they documented their new assumptions. Each group selected response variables and definitions of the level and likelihood of the potential effect. While SPU provided the organizational format and background for the workshop, it did not contribute to the panel discussions that led to the findings of the workshop. Observers were present but were not allowed to engage in the discussion of the scientists.

The conclusions of the worst case analysis workshop participants were based on best professional judgment, referencing personal experience, available data and studies. After the workshop, workshop leads wrote summaries, which were circulated to participants for review and comment to ensure that the summaries accurately reflected the workshop discussion. The workshop leads integrated the comments into the summaries. The workshop summaries reflect the professional judgment of the panelists and were included in the appendices of the SEIS. Seattle Public Utilities then drew on the workshop summaries to develop the worst case analyses included in the Draft SEIS.

General Response No. 4: Content and Approach of the Adaptive Management Plan

Issue: Some commenters requested additional information about the process of developing the AMP, and raised questions about its specificity.

Response: Seattle Public Utilities developed the draft AMP after conducting a literature review, consulting with experts, and considering the results of workshops co-sponsored by Washington Trout and SPU. In developing the AMP, SPU reviewed a wide variety of possible methodologies and approaches, and ultimately selected a method that was reasonable. Uncertainties included for evaluation in the AMP were identified from the work of the independent science group formed to provide recommendations on operating protocols and research, and from public comments about the hatchery on the HCP EA/EIS.

The process included in the AMP for developing scientific recommendations and presenting them to decision makers is most closely related to the Glen Canyon Dam approach to adaptive

management. The Anadromous Fish Committee (AFC) and technical and adaptive management experts as well as WDFW and NOAA Fisheries reviewed the product.

The AMP underwent further review and development to address the decision of the Hearing Examiner. Dr. Barry Gold (a national expert in developing and implementing AMPs) and other experts concluded that this AMP would likely be effective in detecting potential effects and providing a process to evaluate and implement responses, if needed. Quantifiable thresholds associated with measurable criteria have been added to the AMP (see various discussions in Section 2 of the AMP) and will continue to undergo further technical review prior to implementing the AMP, as noted in Table 4-1 of the AMP. The thresholds examine within-year variation between hatchery and natural origin sockeye, or look at response variables for trends or exceedances of pre-established ranges. Statistical tests will be incorporated to provide reasonable confidence that the results are not due to chance. Further review of the sampling designs and statistical tests will occur in consultation with biometricians and through review by the Technical Work Group. Sections 3 and 4.8 of the AMP describe the review process and the roles of those involved if a threshold is exceeded.

As is the nature of adaptive management, the replacement hatchery AMP will continue to evolve as new information becomes available. The AMP will be fully implemented by the time the replacement hatchery begins operations. The AMP includes testable hypotheses, describes initial monitoring priorities, identifies thresholds for the consideration of appropriate response actions, and outlines the process and responsibilities of those involved in responding to threshold exceedances. Follow-up monitoring to evaluate the effectiveness of response actions is included in the AMP. The response process will rely, in part, on data obtained prior to implementation of the AMP for comparisons with post-AMP results.

Overall responsibility for adaptive management is assigned to the Parties to the LMA (NOAA, USFWS, WDFW and the City of Seattle). Section 4 of the AMP specifically identifies the responsible parties and their responsibilities. The various AMP groups will be held accountable by the Parties to the LMA for fulfilling their specific roles in order to provide the needed information to the hatchery managers.

One specific goal of the AMP is to, “Promote a high standard for scientific work so that results are credible.” Section 4.4.4 of the AMP, as an example, establishes independent science advisors to serve the function of a truly independent professional board. Meeting this stated goal will require the development of sound scientific direction. Seattle Public Utilities is committed to meeting this goal and has structured its current effort around this principle, which will continue as the AMP is finalized.

General Response No. 5: Funding of the Adaptive Management Plan

Issue: Some commenters expressed concern that funding would not be available to implement the AMP and hence that it should not be accepted as mitigation for possible impacts of the hatchery.

Response: The Cedar River HCP makes a 50-year funding commitment for sockeye monitoring and research for the Cedar River Hatchery. Additional funding and in kind contributions have

supported complementary research on sockeye and their ecology in the Lake Washington basin, and it is likely that similar work will continue and provide additional information useful to adaptively manage the sockeye hatchery program. As with other elements of the HCP, the replacement hatchery and the AMP are to be funded with revenues from SPU water utility ratepayers.

The AMP sets up a structure through which resources can be allocated to ensure that the most important questions, as recommended by independent scientists, will be pursued. Funding described in the AMP is meant to indicate the likely use of funds in the first 10 years. Research and monitoring for later years will be determined as early year study results are analyzed. The funding is not unlimited and the scientific groups described in the AMP will be charged with making recommendations to the Adaptive Management Work Group and the Parties to the LMA about the best use of the available funding.

General Response No. 6: Relationship to Water Resource Inventory Area (WRIA) 8 and Chinook Recovery

Issue: Comments on the SEIS included questions about the links and relationships between the proposed replacement hatchery and the WRIA 8 Salmon Conservation Plan (Plan). They suggested that money spent on the hatchery would be better spent on increasing habitat in the lower Cedar River. Commenters also raised concerns about the impacts of the proposed replacement hatchery on Chinook recovery.

Response: These comments address issues that are not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner.

The WRIA 8 Plan focuses on strategies, including habitat work, associated with Chinook salmon recovery; other salmon recovery efforts, such as those for sockeye, are not specifically addressed. The WRIA 8 Plan is expected to be considered for inclusion in the Draft Puget Sound Chinook Evolutionary Significant Unit (ESU) Conservation Plan that is expected to be issued by NOAA Fisheries (NMFS) later in 2005. The City of Seattle is a partner in the development of the WRIA 8 Plan, and it shares the goals of salmon conservation. NOAA Fisheries is the federal agency that is responsible for administering the Endangered Species Act for Chinook and therefore is charged with issuing the Puget Sound Chinook Recovery Plan. NOAA Fisheries is also a party to the LMA, the legal document that is foundation to the development of the replacement hatchery.

NOAA Fisheries approved the Cedar River HCP in April 2000, after the listing of Chinook salmon as threatened under the Endangered Species Act. The Cedar River Sockeye Hatchery is included in the HCP, which was reviewed by NOAA Fisheries before it approved the HCP and issued its 2000 Biological Opinion on the effects of the HCP, including those from the proposed replacement hatchery, on Chinook. NOAA Fisheries has stated that "potential adverse effects to Puget Sound Chinook from sockeye supplementation are expected to be slight." (Biological Opinion, April 2000, p. 99). The NMFS also submitted comments on the Draft SEIS. Their comment letter states that, "The Worst Case Analysis is consistent with the April 2000 NMFS BioOP and Findings. There are no new substantial affects[sic] identified that would indicate that

NMFS should reanalyze anything." The NOAA Fisheries comment letter is included in the comment letters following these general responses.

At the time of this writing, NOAA Fisheries has not yet reviewed the WRIA 8 plan nor issued a Puget Sound Chinook Recovery Plan. The Technical Recovery Team (TRT), an advisory group to NOAA Fisheries, has reviewed and commented on the WRIA 8 plan.

Potential adverse interactions between sockeye and Chinook have been discussed in this SEIS as part of the worst case analysis to supplement the evaluations provided in previous environmental review documents. Commenters are referred to Chapter 3 of the SEIS for discussion of possible impacts and the likely magnitude of those impacts.

There is no doubt that habitat restoration is also important both for Chinook recovery and to support other salmonids that depend on the Cedar River. The alternative chosen by SPU for sockeye mitigation includes $1.6 million (1996 dollars) in habitat investments. In addition, the City of Seattle has made, and will continue to make, investments in habitat through its HCP and through its participation in WRIA 8. The HCP provides substantial funding for habitat enhancement (a total of $4.637 million, in 1996 dollars) and SPU, in cooperation with King County, has used the HCP as a foundation to secure $2.5 million in additional habitat protection funding through USFWS grants. In addition, SPU contributes millions of dollars to protect and to restore upper watershed habitat that contributes to protection of downstream water quality.

Seattle Public Utilities agrees that habitat change, whether it results from the effects of development, from habitat restoration projects, or from some other cause, should be considered in the evaluation of monitoring results on productivity in the Cedar River. Historically, sockeye and Chinook coexisted for many decades and at times coexisted at higher levels than currently exist, suggesting that sockeye and Chinook recovery efforts can both be successful. For further discussion of the overall approach to managing for multiple species in the context of the HCP, please see Section 4.3 of the HCP.

From: Matthew Longenbaugh <matthew.longenbaugh@noaa.gov>
To: <vikki.anselmo@seattle.gov>
Date: 3/18/2005 12:33:24 PM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

Hi Vikki, i am submitting this letter by e-mail to ensure it is rcvd by March 21. And will follow up with a hard copy next week.

I am submitting this letter as the Acting State Director for NMFS Habitat. Hard copy will be signed by Steve Landino, State Director, who is not available today.

Matt Longenbaugh
Branch Chief for Central Puget Sound
Habitat Conservation Division
NMFS

360-753-7761

Comment Letter NO

Vikki Anselmo
Seattle Public Utilities
700 5th Ave, Suite 4900
PO Box 34018
Seattle, WA 98124-4018

Ms. Anselmo:

1 Thank you for the opportunity to comment on the Cedar River Sockeye Hatchery Project Draft Supplemental SEPA EIS. We commend Seattle Public Utilities (SPU) for preparing such a thorough and well reasoned analysis of potential impacts of the Cedar sockeye hatchery. When NOAA's National Marine Fisheries Service (NMFS) approved the Cedar River Watershed Habitat Conservation Plan (HCP) in April 2000, we agreed with the operations of the pilot and expanded Cedar sockeye hatcheries along with the design of the expanded hatchery facilities.

We are pleased that since 2000, SPU has developed an Adaptive Management Plan and SEPA analyses of the expanded sockeye hatchery, as described in the Landsburg Mitigation Agreement (LMA). This effort by SPU is in full compliance with the LMA commitment to a "comprehensive public involvement and environmental review process for the long-term hatchery program" (LMA section D.1.b.). And, according to the HCP and LMA, NMFS expects to discuss with SPU and the other Parties the final sockeye hatchery proposal after the SEPA process is completed and before the Parties are asked to approve "the capacity, design, operating guidelines, and adaptive management program" (LMA section D.1.b.).

While NMFS staff had reviewed and indicated support for the preliminary Adaptive Management Plan (March 2003 draft), we are pleased that SPU has strengthened that Plan with additional information and provision for ongoing public involvement. We understand the City expects the key questions to be mostly answered after 3 to 4 sockeye generations, i.e., 12 to 16 years. NMFS does have a few questions and comments on the Adaptive Management Plan.

2 1. Regarding the Technical Work Group and Independent Science Advisors , have individuals been identified for participation on these committees?

3 2. Are funds designated for participation on the Technical Work Group or Independent Science Advisors group? It may be difficult to get key players to allocate time without funding for participation. NMFS will attempt to contribute staff for these important groups to be effective.

4 The Worst Case Analysis is consistent with the April 2000 NMFS BiOp and Findings. There are no new substantial affects identified that would indicate that NMFS should reanalyze anything.

5 We look forward to reviewing the public comments on the DSEIS and the Final SEIS with the other Parties before the expected decision point in June 2005. If you have questions, please contact Matthew.Longenbaugh@noaa.gov , 360-753-7761.

Steve Landino
Washington State Habitat Office Director

cc: Tim Romanski, FWS
Bob Everitt, WDFW
Bruce Bachen, SPU

Responses to Comment Letter NO (NOAA)

NO-1. Comment noted.

NO-2. Individuals have not yet been identified for the Technical Work Group or the Independent Science Advisors. As noted in Section 4.4.3 of the Adaptive Management Plan (AMP), members of the Technical Work Group will, "be selected by the parties to the Landsburg Mitigation Agreement (LMA) in consultation with the Adaptive Management Work Group." Section 4.4.4 describes the process for establishing the group of Independent Science Advisors. This process also relies on the Parties to the LMA, who will solicit nominations from the stakeholder groups and the public at large, and will get the advice of the Adaptive Management Work Group before finalizing the names of the Advisors.

The selection process is part of the startup of the adaptive management process, which should begin as soon as the environmental review process is complete.

NO-3. Specific funding for participation of these groups is not currently identified. A number of scientists have participated on technical committees associated with the development of the hatchery program to date without specific compensation. If funding becomes an issue, this will need to be discussed and addressed by the Parties to the LMA during the startup of the AMP process.

NO-4. Comment noted.

NO-5. All comments received are included in the FSEIS and will be distributed to the Parties for review prior to beginning the review process established in the LMA.

WASHINGTON DEPARTMENT OF FISH AND WILDLIFE
FISH PROGRAM
Science Division

TO: Jim Scott, Chuck Johnson

FROM: Craig Busack

SUBJECT: Comments on Cedar River Sockeye Hatchery SEIS

1 I've had far less time to review this document than I would like to have had, but can offer some comments. In general the document is excellent. It's well written and covers the material very well. I especially like the forthright way that possible issues with the hatchery are brought up and dealt with. The worst-case scenario workshop process was very good, and the write-up of the conclusions from the workshop is very good. I think it is a great strength of the document that the workshop summaries accurately reflect the diversity of opinions of participants.

I have a few suggestions for strengthening the document, listed here in order of importance. I'd be happy to discuss them at length with SPU biologists or their consultants, especially my comments on genetics. There is much more that could be discussed here.

2 1) **Make adaptive management monitoring more rigorous by using power analysis to revise the designs.** There is a serious flaw in the AMP in that there is no indication that the experimental designs for monitoring have considered statistical power. The AMP says repeatedly that certain measures will kick in if statistically significant differences are found, and discusses in detail the funding levels for each measure, but this is not sufficient. What must be addressed is what level of difference is going to be considered biologically significant and what sample sizes will be necessary to detect it. For example, in discussing fry size, the document mentions work by Bams that suggests that a size difference of 2-3mm can have serious implications for swimming. Based on this, you might decide that you want to be able to detect a real mean size difference between hatchery and wild fry of 3 mm with a given probability. If you know the variance of length, you can then determine what sample size is necessary to detect a difference of this magnitude at the α=0.05 level with a specified probability. In other words, for the plan to be adequate you must be able to show that the resources you are dedicating to it will be able to detect what you want to detect. Power analysis is often overlooked, especially in this business, but it is dealt with in detail in all good general biometrical texts as well as books dedicated to the subject. There are also a number of software packages now available. The risk of not doing power analysis is huge. You may find in time that you are monitoring phenomena in which you have no chance of ever detecting an important change when it occurs, or that you are spending way to much monitoring phenomena where changes are very easily detected. My guess is that when power analysis is done, you may find that there is not enough money to do an adequate job in all areas and be

Comment Letter FW

2 forced to cut measures. As presently written, the AMP implies that the plan may change, but still implies that all these things will be done.

3 2) **Put hatchery-wild similarities in proper perspective.** There is a strong emphasis in the document on hatchery-wild differences, especially monitoring to assure that the hatchery and wild fish are virtually indistinguishable in many characters. Unfortunately, you can have major changes in the population and still have the hatchery and wild components be indistinguishable. Because this will be an integrated program, hatchery and wild fish will be genetically nearly identical (at least asymptotically), so you can expect them to be not very different phenotypically, but the population could still change in a negative direction, due to domestication for example. I would argue that what you really want is for the population to remain very close genetically and phenotypically to what it was before the hatchery was started. Monitoring hatchery-wild differences is still important because the differences may indicate strong selection differentials, but what you really want is to not have the population change over time *due to the hatchery*. You can't truly judge whether things have changed due to the hatchery without an unimpacted control line, of course, so you can't guarantee you will be able to detect any important change. The key risk containment measure is the way you operate the hatchery, as an integrated population with levels of gene flow between the natural and hatchery components to minimize risk, and with minimally invasive hatchery practices. Bottom line- continue to emphasize monitoring hatchery-wild differences, but remove impression that no difference means no problem by also tying monitoring to historical trait characteristics.

4 3) **Discussion of genetics is unclear in AMP.** The genetic effects of hatcheries are always a big concern, and this hatchery is no exception. A major concern is domestication. Domestication results from differences in selective regimes experienced by natural fish and hatchery fish. The changes are sometimes subdivided into those due to relaxation of selection (things selected against in wild are not selected against in hatchery) and antagonistic selection (things selected against in wild are selected for in hatchery and vice versa). Domestication is not easily monitored directly; what is done instead is to look for changes in quantitative traits that are presumed to be under genetic control, and a lot of domestication change can be considered loss of fitness, which equates to reproductive success. The problem I see is that the AMP artificially makes an artificial distinction between genetic and nongenetic factors, and then makes things doubly confusing by suggesting the specific genetic monitoring measure for effective size. I would state up front that domestication is the major concern, and point out which monitoring measures are related to that (most are), then briefly mention the other genetic concerns of gene flow and effective size. Also I suppose effective size is worthy of inclusion for the sake of completeness, but it is unlikely to be a problem unless the population size drops drastically. Monitoring effective size is difficult to achieve with any level of precision except by using pedigree analysis.

Responses to Comment Letter FW (WDFW)

FW-1. Comment noted.

FW-2. The City agrees with the commenter's suggestion that study design needs to be rigorous and should consider power analysis in establishing sufficient sample sizes for conducting statistical tests. Application of power analysis requires knowledge of the variability of the monitoring variable and determination of the magnitude of change that is biologically meaningful. Recommending final study designs will involve the Technical Work Group and the Independent Science Panel, as was described in Section 2.7.2 of the DSEIS, and also in Section 4.4 of the AMP. As stated on p. 1-9 of the AMP, the plan *outlines* (emphasis added) a proposed research and monitoring program: "…final determination of the elements of the program will be made as a part of the formal adaptive management process… Contracted researchers will develop detailed study plans at a later date. Detailed study plans will include a power analysis when appropriate, which specifies necessary sample sizes, minimum detection levels, and appropriate significance levels so that there is confidence in study results and the ability to make management decisions based on them."

The commenter's concern about the level of funding has been shared by others. See General Response No. 5. As stated in the AMP, p. 1-9, the budget allocations focus on the first 10 years and may shift over time as knowledge is gathered. Additional budget for later years is discussed in the HCP, Section 5.3.6. Language has been added to the AMP to clarify this issue.

It is, however, likely that there will not be sufficient funding to fully explore every possible scientific issue. Therefore, the AMP specifies that the Adaptive Management Work Group (AMWG) is responsible for recommending multiple-year budgets to the Parties to the LMA (NOAA, USFWS, WDFW and the City of Seattle) and for recommending the establishment of priorities for program implementation (see Section 4.4.2 of the AMP). The Technical Work Group, a scientific body, will develop monitoring and research objectives, protocols and plans; develop and review budgets and Requests for Proposals (RFPs) for monitoring work; and provide advice as needed to ensure that the monitoring and research objectives are relevant, realistic and scientifically credible (see Section 4.4.3 of the AMP). These groups must recommend to the Parties the appropriate use of the available funds and provide advice on the consequences of potential tradeoffs.

FW-3. Comment noted.

Seattle Public Utilities agrees that evaluating differences in monitoring parameters over time is important. Data from the pre-hatchery and interim hatchery period, where available, will be used in various analyses to evaluate whether or not change is occurring over time. Examples of data that will be used in trend analyses include size at age of maturity, age at return, outmigrant fry timing, spawn timing, and spawner

distribution. In some cases the collection of data will begin with the implementation of the HCP monitoring commitments or the AMP, which will limit comparisons of monitoring results to that point forward.

FW-4. Comment noted. This comment will be helpful in refining monitoring objectives and establishing their priority. The discussion of non-genetic variables was intended to recognize that influences, other than genetic change, affect reproductive traits and will need to be accounted for in the analysis of genetics effects. As the Technical Work Group refines the studies that they will recommend for funding, your comments will be conveyed to them.

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March 21, 2005

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Re: Official Comments to the Cedar River Sockeye SEIS

Dear Ms. Anselmo:

I am submitting these comments on behalf of Roz Glasser, and on my own behalf as a citizen of Seattle and rate payer of Seattle Public Utilities (SPU).

The Supplemental DEIS (SDEIS) was prepared in response to the Seattle Hearing Examiner's decision in Ms. Glasser's appeal of the FEIS for the Cedar River Sockeye Hatchery. Hearing Examiner No. W-03-001 (November 10, 2003).

1 A major purpose of the SEPA EIS process is to adequately inform the public and the decision-makers about the consequences of the proposed action. SMC 25.05.400(B). A key component of this disclosure is the consideration of alternatives "that could feasibly attain or approximate a proposal's objectives, but at a lower environmental cost or decreased level of environmental degradation," including a "no-action" alternative. SMC 25.05.440(D)(2).

SPU has rejected repeated requests by Ms. Glasser and myself to expand the scope of the SDEIS to include consideration of a number of assumptions, including whether the hatchery should be built at all in order to meet the stated goals, and whether there are other actions that would better accomplish the stated goal (i.e., "no action" and "habitat based" alternatives). SPU takes the position that the SDEIS need not address any issues beyond a worst case analysis and "details about SPU's proposed Adaptive Management Plan." SDEIS, pp. 1-1 to 1-3. SPU claims that the FEIS for the 1999 Cedar River Habitat Conservation Plan adequately evaluated "programmatic alternatives for the hatchery program." SDEIS, p. 1-8.

SPU argues that the Hearing Examiner's 2003 decision forecloses any such analysis or consideration in this SEIS: "With respect to all other issues addressed
2 in the appeal, the Hearing Examiner's decision affirmed the adequacy of the FEIS." SDEIS, p. 1-1. This conclusion is not correct legally, and is a calculated attempt to prevent the City and its citizens from obtaining an honest evaluation of the real costs, benefits, and alternatives to the proposed hatchery.

Comment Letter TT

I. The Hearing Examiner's Decision Does Not Preclude SPU Consideration of Hatchery Assumptions and Programmatic Alternatives.

It is apparent from the above that SPU believes that collateral estoppel or "law of the case" prevents Ms. Glasser from raising any questions concerning the adequacy of the 1999 HCP EIS with respect to the hatchery. In any appeal of the SDEIS, SPU will likely take the same position with respect to the 2003 FEIS:

> The FEIS also evaluated a No Action Alternative and provided a review of information on project-specific biological effects of the proposed hatchery that updated the programmatic evaluation described in the Cedar HCP FEIS.

SDEIS, p. 1-8.

These positions are wrong for at least the following reasons:[1]

• Failure to fully review the fundamental factual and legal assumptions underlying SPU's position that "the hatchery must be built" would constitute a manifest injustice.

2 • The Hearing Examiner dismissed the HCP issues before hearing. There was no full and fair adjudication of these claims, and, since Ms. Glasser won a remand of the EIS on two major issues, there was little incentive to expend the enormous resources it would have taken to appeal to superior court or further.

• Before the Hearing Examiner, Ms. Glasser raised the requirement that; "When preparing a project EIS … the lead agency shall review the nonproject EIS to ensure that the analysis is valid when applied to the current proposal, knowledge, and technology. If it is not valid, the analysis shall be reanalyzed in the project EIS." SMC 25.05.443(C); Appellant's Post-Hearing Brief, p. 9. The Hearing Examiner did not cite or reject this issue in the decision. Today, six years after the HCP EIS and two years after the FEIS, even more evidence is available concerning "current proposal, knowledge, and technology" showing that the HCP EIS did not adequately address the underlying assumptions about or alternatives to the proposed hatchery.

SPU has a duty to comply with SMC 25.05.443(C). The following two sections summarize the reasons why SPU must review the legal and scientific assumptions in the HCP EIS and FEIS supporting the decision to construct the Cedar River Sockeye Hatchery.

---

[1] See Paradise Orchards General Partnership v. Fearing, 122 Wash.App. 507, 514-516, 94 P.3d 372 (2004); Barr v. Day, 124 Wash.2d 318, 324 - 325, 879 P.2d 912 (1994); Hanson v. Snohomish, 121 Wash.2d 552, 561, 852 P.2d 295 (1993).

II. SPU's Reliance on an "Obligation" to Mitigate for Impacts of the Landsburg Diversion on Sockeye as a Reason to Construct the Hatchery Fails as a Matter of Law

The most basic premise regarding the proposed Cedar River Sockeye Hatchery is that it is required to meet City obligations due to "sockeye migration blockage created by the Landsburg Diversion Dam as defined in the Landsburg Mitigation Agreement, Senate Bill 5156, and other applicable state and federal laws."

First, there is no federal law that obliges the City to take any action with respect to Cedar River sockeye except to ensure management of sockeye mitigation does not adversely impact ESA listed runs.

Second, it is not clear that there is any "other applicable state law" that requires action beyond what has already been done. The history of negotiations between the state fish and wildlife agencies and the City clearly indicate that the only statutory basis for a claimed obligation is RCW 77.55.060, which requires "a durable and efficient fishway" on dams or other obstructions. SPU's obligation under this statute has been discharged by the construction and opening of the fish ladder at Landsburg. That fishway, provided for under the HCP and the
2 Landsburg Mitigation Agreement (LMA), provides for passage, not an explicit amount of production of any species or run of fish.

Third, SB 5156, which is codified at RCW 77.100.100 – 160, provided for construction of a spawning channel. The word "hatchery" does not appear once. An EIS was prepared for the spawning channel, but it was never implemented, and SPU has never relied on that EIS to support the now proposed Cedar River Sockeye Hatchery.[2]

At the end of the attempt to construct the spawning channel, correspondence in the state's files foreshadows the problems that followed the hatchery proposal into the HCP and LMA negotiations.[3]

III. Hatchery Assumptions and Programmatic Alternatives in the 1999 HCP EIS and 2003 FEIS Are Contradicted by Current Knowledge

SPU states that the goal for the Cedar River Sockeye Hatchery is as a "supplementation" program to "augment" the existing naturally spawning run so as to "increase sport and tribal harvest opportunities of the Lake Washington sockeye salmon fishery." SDEIS, p. 1-7, 1-9.

[2] SPU's statement that "Prior to the Cedar HCP and Landsburg Mitigation Agreement, the Washington State legislature in 1989 passed Washington State Senate Bill 5156 (codified in RCW 77.100) that enabled the construction of a sockeye hatchery on the Cedar River." (SDEIS, p. 1-5, emphasis added) is disingenuous and misleading. That law certainly was the excuse for the interim hatchery actually constructed in 1991, but it clearly did not authorize it.
[3] E.g., January 19, 1993 letter from Bob Turner to Brad Owen. Attached.

SPU persists in misstating the nature and purpose of the hatchery in light of the current knowledge about the impacts of hatcheries. For example, SPU does not cite the National Research Council book, Upstream: Salmon and Society in the Pacific Northwest, 1996, which states, "The term "supplementation" as a goal of hatchery programs should be abandoned." P. 321.

The most fundamental assumption SPU makes is that the hatchery must produce "up to 34 million sockeye fry annually." SDEIS, p. 1-1. This figure is suspect. As the attached 1996 memo from Jim Ames to Kurt Fresh shows, the figure "is not appropriate ...as the final mitigation objective."

2

Another basic assumption SPU has carried forward but refuses to revisit is that allowing sockeye above Landsburg will impermissibly negatively impact water quality. This assumption, like the "34 million fry" assumption, is based on non peer reviewed studies, and is contradicted by recent actions. SPU does allow non-sockeye above Landsburg; the question that should be addressed is not the species that are allowed upstream, but the total biomass that would be acceptable. Further, more recent scientific research indicates that even large numbers of sockeye might not jeopardize the quality of water withdrawn at Landsburg. See Feasibility Of Reintroducing Sockeye And Other Species Of Pacific Salmon In The Coquitlam Reservoir, BC, R.C. Bocking and M.N. Gaboury, Bridge-Coastal Fish and Wildlife Restoration Program, March 2003.[4]

IV. The SDEIS Is Inadequate in the Two Analyses SPU Did Conduct

A. Worst Case Analysis

The worst case analysis (WCA) is deficient in a number of respects, the most serious being:

3 • The process for conducting the WCA was biased by SPU: selecting the participants with a view toward preventing an objective review of the project; and preventing the participants from having adequate time and information to conduct an objective review. This flaw was compounded by the failure to allow questions to be added or changed.

4 • The WCA was not based on the precautionary principle.

5 • The WCA did not include a discussion of effects on the river ecology or due to weir operation (both issues were raised in the SEPA appeal).

Details on these and other points are in the attachment.

[4] Available at http://www.bchydro.com/bcrp/reference_reports.html.

B. The Adaptive Management Plan Is Inadequate

6 SPU persists in presenting the Adaptive Management Plan (AMP) as a post hoc justification for a project that in reality has been in place for a dozen years. There are two fundamental flaws with the AMP:

7 • The data produced as a result of twelve years of interim hatchery operation shows that many of the "unknowns" are not unknown, but in fact can be answered in the negative. For example, the otolith studies show that many of the hypthesis in 2.1.4 are likely to be contrary to the project's hoped-for goals.

8 • The AMP still contains no quantifiable triggers ("potential outcomes") related to the "potential response outcomes." The plan's triggers consist mainly of the word "significant." The results are almost without exception vague, and when they actually suggest a concrete action ("Modify facility design," "Reduce hatchery fry production") there is no indication of how they will be accomplished, qualitatively or quantitatively, or if money will be available to accomplish the needed change. And should these results not also be part of the worst case analysis?

9 We suggest that SPU refer to the most comprehensive adaptive management process currently in place in Washington State—the 1999 Forests and Fish Report (FFR) and implementing laws and regulations.[5] The FFR adaptive management process requires, inter alia, the following elements:

(i) A set of protocols and standards to define and guide execution of the process; objectives must be defined in measurable criteria;

(ii) A set of participants empowered to conduct the required activities;

(iii) A baseline data set used to monitor change; and

(iv) Adequate funding to conduct the necessary research, monitoring, and peer review.

See WAC 222-12-045,

While legitimate criticisms may be made of the FFR and its adaptive management process,[6] any adaptive management plan that does not provide at least these basic elements is not going to be successful. The proposed AMP for the Cedar River Sockeye Hatchery is clearly deficient in each of the above enumerated areas:

[5] The Forests and Fish Report and related documents are available at http://www.dnr.wa.gov/forestpractices/rules/.
[6] See reports and reviews at http://www.governor.wa.gov/gsro/science/documents.htm and http://www.sernw.org/for_fish/ff_doc.htm.

10 (i) Measurable criteria are largely absent;

11 (ii) Participation is largely tied to the LMA and its advisory Anadromous Fish Committee (AFC), both heavily weighted toward hatchery advocates;

12 (iii) Despite twelve years of operation of an interim hatchery, there is no baseline data set; and

13 (iv) Adequate funding is not assured to conduct the necessary research and monitoring, and an objective peer review process does not exist.

14 More detailed comments and questions are in the following pages. We would appreciate full and direct responses in the FEIS.

Sincerely,

Toby Thaler

cc: City Council, Utilities & Technology Committee
Jim Compton, Chair
Nick Licata, Vice Chair
Jan Drago, Member
Peter Steinbrueck, Alternate
Richard McIver, Alternate
City Council, Budget Committee
Richard McIver, Chair
Richard Conlin, Member
David Della, Member
Jean Godden, Member
Tom Rasmussen, Member
Rest of Members as Above
City Attorney
Will Patton, Director, Utilities Section

Cedar River Sockeye Hatchery Issues
Comments and Questions

Generally

15 Consistency with WRIA 08 Salmon Conservation Plan– Millions of dollars and several years of effort have gone into salmon conservation planning. If approved by forum governments, much more will be spent in the future. However, the hatchery's compatibility with the plan has not been assessed and remains a major uncertainty in the WRIA plan's ability to restore Chinook and other native salmonids. How will the CRSH be accounted for in WRIA salmon conservation planning? How will effects be remedied if they are found? Who will pay?

16 Monitoring and Adaptive Management Plan– The City has consistently indicated it would deal with uncertainties through a science-based plan for monitoring and adaptive management. Further, it has indicated that such a plan would be in place before construction. Will there, in fact, be a CRMP with adequate funding in place before the hatchery is constructed – or ever?

17 Lake Washington Studies– Started in 1992, these were intended to assess Lake Washington's carrying capacity, effects of hatchery fish on the ecosystem and ability to meet fry-comparability requirements of the state law. In essence, the "temporary" hatchery was an adaptive management experiment that has failed because the City has consistently avoided or waited to bring data from the studies (except where it supports their desires) to bear on a final decision. Considerable time and money has been spent on these. Over ten years later, there is still no comprehensive summary of the work and its results. Why is the city ignoring this work and its potential value for adaptive decision-making? Why can't the City first complete and synthesize the results of these studies (after all the temporary hatchery has been extended another two years…)? Is it the City's intent to complete these studies? If so, when? If not, why not?

18 State Law requirements—Original state law required a spawning channel (language has never been changed) not a hatchery, which (see above) was a temporary measure for an experiment that has never concluded (or perhaps it has concluded and has failed). It also required that artificially produced fish be comparable to naturally produced fish. Available data (e.g., Fresh 2003) shows this is not happening and the authoritative literature indicates it is unlikely to ever happen except by thoroughly mixing up (homogenizing) hatchery and wild fish, the most likely net effect of which is to reduce the overall quality and fitness of the run. Is the City planning on changing state law to bring the proposed hatchery into compliance? If so, when? If not, why not?

19 Hatchery as WRIA-level Mitigation – Emerging WRIA strategy to meet huge funding needs for habitat work is to redirect mitigation funds. Why is this hatchery exempt from that emerging strategy? It is the single largest expenditure of mitigation funds for a fish oriented project in Lake Washington (maybe entire

19 Puget Sound). Ironically, it is being built: 1) to help a non-native run of fish, in a manner that at best will only be a slight drag on native fish recovery and could be a major drag, 2) without any review of its effects on WRIA salmon conservation goals, 3) without an adequate monitoring or adaptive management plan, 4) at a time when numerous habitat based opportunities exist and money for implementing them is in extremely short supply. Given the high priority of habitat-based approaches and lack of money to fund them, why couldn't the hatchery be delayed, downsized or abandoned in favor of habitat alternatives?

20 Use of the Hatchery for other species– At the time of the HCP EIS, the City assured the public that the hatchery was only intended for sockeye use. Has that position changed? If so, has any potential change in use been analyzed for effects, either in WIA plan or separately? Have there been discussions about using this hatchery for other species?

What's new since the HCP EIS was completed in 1998?

21 1) A WRIA salmon conservation plan which has not assessed impacts of the hatchery and in which the hatchery remains one of the major risk factors identified by NOAA's Puget Sound Chinook Technical Review Team (TRT);

22 2) The Puget Sound Chinook TRT has concluded that of the 22 extant Chinook populations none are expendable (and in fact several extinct populations should be recovered) and the Cedar River is in the highest tier of concern and need for recovery;

23 3) Two reviews conducted by two separate RSRPs (NOAA's highest level independent science advisory panel) have concluded in two separate reports (one published in Science in 2004, one an internal technical memo) that hatcheries carry high risk of effects. This adds to the extensive body of literature about hatchery problems and risks which the city and hatchery advocates continue to ignore or downplay, instead only citing supportive reports;

24 4) An emerging WRIA funding policy that would use mitigation dollars for problems such as this, i.e., where in-kind/in-place options are not available, and funnel them into habitat-based mitigation measure to help cover the large funding needs for Chinook recovery;

25 5) Additional data (which the SEIS continues to ignore or downplay) on effects of the weir on Chinook migration and distribution;

26 6) Report by Fresh, et al. (2003) which concludes there are significant differences between naturally spawning and hatchery fish after just one generation of hatchery operation;

27 7) Still no summary of over twelve years of study of hatchery and naturally spawning fish, and lake and river conditions as the part of original adaptive management experiment (see description in Fresh, et al. (2003) which the City has again failed to acknowledge, acting instead as if little is known and there have been no legacy effects of operation of the temporary hatchery (which was built to conduct the experiment);

28 8) The SDEIS acknowledges that it is virtually impossible to prevent the genes of wild sockeye from mixing with those of hatchery sockeye resulting in less fit fish overall. This is a direct violation of the original Washington State law (ESB 5156) that required artificially produced fry to be comparable to wild fish.

29 9) The City and its SDEIS still fail to recognize and fully utilize the original experiment in adaptive management which started with the existing hatchery. There is still no summary of over ten years of study (under the original adaptive management experiment) on the current temporary hatchery and its impact on wild fish, and lake and river conditions. (See Fresh, et al. (2003), for more explanation and history for these studies.). SPU has both criticized this study as statistically inadequate (when it said what they didn't want to hear) and yet has used the results in the SDEIS to help prove a point favorable to the hatchery proposal. Fresh et al (2003) found that after only one generation differences among wild and hatchery females fish were evident (hatchery fish were returning smaller consistent with most other research), and additional data suggests that timing, migration and spawning distribution are being impacted by the temporary hatchery's operations.

30 10) If the hatchery becomes fully operational (producing 34 million sockeye fry annually), and the WRIA 8 plan increases Chinook populations with habitat improvements, it raises questions as to: 1) whether there is enough food in Lake Washington to support both populations at sustained levels, 2) whether increased sockeye numbers will cause them to spawn on top of (and potentially harm) Chinook redds, and 3) whether Chinook will be forced to spawn in undesirable sites subject to high flows or scour which could lower their reproductive success and 4) impacts to nearby native populations, especially the Pleasure Point beach spawners. (The hatchery proposes to more than double the number of sockeye a temporary experimental hatchery has been producing since 1992. The potential impact on Chinook recovery was not listed in the "worst case scenario" examined in the SEIS.

31 11) The hatchery's recommended budget is for approximately 10 years of AMP-related studies, including study of potential impacts, yet it is expected to operate for at least 50 years. No funding is identified for fixing any identified negative impacts on Chinook or other salmon runs. In effect, the SSEIS commits the City of Seattle to fund these projects during an era of tight city budgets. It is not clear where these funds will come from and there is a concern that these costs may negatively impact habitat-based mitigation funding for Chinook recovery.

Detailed comments on the main body of the SDEIS

32 The SDEIS repeats the statement that the hatchery is "required" by the HCP. This isn't true. The HCP and LMA clearly provide for shifting of resources to other options if the hatchery is not built. SPU has still not produced a "no action" alternative that compares how "no-hatchery" alternatives compare with the hatchery in terms of meeting the stated goal of producing more harvestable fish, and in terms of risks to other resources (Lake Washington and Cedar River ecosystems, Chinook ESU recovery).

1.2.4 Existing interim hatchery

33 P. 1-5, ¶4: Stating that the IHN viral control work at the hatchery has been effective suggest there haven't been any problems and thus is misleading. Please provide accurate details of how many fish have had disease and of those how many were killed and how many were released. Also, what is the risk to hatchery goals should the water supply become contaminated? How realistic is it to assume the springs will never become contaminated? How would a series of springs be treated and how realistic and expensive will that be? Is there an alternative water supply in case that happens?

34 P. 1-6: Please note for the public that the HCP covers possible actions; it doesn't "require" a hatchery capable of producing up to 34 million fry.

35 1.3 Project Objectives

As stated, it appears that the first two are substantially different from what was called for in ESB 5156.

36 1.4 Previous Environmental Review

The 1999 FEIS for the HCP is now inadequate (see list of what's new since 1999) given new information about how the interim hatchery has performed, impacts of hatcheries in general, high urgency for Cedar River Chinook protection and recovery and WRIA 8 salmon conservation plan.

1.5 Adaptive Management Plan

37 P. 1-9, ¶2: a) Second bullet: laws say "comparable" b) Third bullet: what about beach spawners?

38 P. 1-9, ¶4(last): Should note that in this case a far less impacting alternative was NOT chosen, thus this "hard decision" was forced on the system rather than being the only realistic way to achieve a certain institutional goal.

39 P. 1-11. ¶2: Funding is inadequate. Please show how funding is sufficient to cover all future monitoring and potential AMP-driven changes.

1.6.2 Methods used to develop the SDEIS worst case analysis (WCA)

40 P. 1-13, ¶1: What criteria were used to select WCA participants? To what extent, if any, are any of them also receiving funds for projects they are conducting as part of the HCP or for other city-related environmental work?

41 P. 1-14: last bullet, this does not appear to be consistent with what is described in the WCA section on redd superimposition effects.

42 General comment: Were the WCA reports and conclusions ever subjected to independent review? Who determined that "low or minor impacts" are OK? What criteria were used?

43 1.7.1 Straying: OK, except for beach spawners, not OK to just assume other factors (such as increased harvest as a result of increasing the run of harvestable Cedar River fish) will be a problem… bottom line – it appears the "other problems" are mostly the result, either directly or indirectly, of the hatchery.

44 1.7.2 Homogenization: Which scientist concluded this would only be a minor effect? Were these conclusions reviewed by independent scientists?

1.7.3: Domestication:

45 1.7.4: Predation: The conclusion that doubling the fry will have no effect on predator abundance is amazing. Where does the food come from and how does it get replenished if overcropped?

46 1.7.5: Food supply: The last sentence seems to downplay the critical fact that the participants assumed existing levels rather than a doubling of sockeye fry. This is not an adequate analysis.

47 1.7.6 Spawning Ground Competition: This analysis is replete with illogical and completely unfounded suppositions that the problem is avoidance rather than competition and that the Chinook are simply spawning in equally good areas when they are displaced under high sockeye spawner abundance. Observations that sockeye are not aggressive toward Chinook and that Chinook are not being forced out is inconsistent with observations of other biologists with experience on the Cedar River. Where is the independent review of these conclusions?

48 1.7.7: This conclusion relies on untested or unverified assumptions. For example, it assumes the gravel is sufficiently deep for Chinook to actually spawn deeper than sockeye and that cobbles that Chinook deposit eggs in are too large for sockeye to move. Both of these are unsupported by any evidence. No measures of Cedar River gravel depths are presented (to ensure the effect stated is real) and no indication that the Cedar River cobbles are in fact so big that sockeye couldn't in fact move them. Further more it has been observed that sockeye spawn for extended time (weeks to months) after Chinook have spawned and tend to favor areas that Chinook have already softened up by their redd building

48 activities. Thus sockeye are actually targeting Chinook redds to spawn on top of. Also, fails to account for other factors that may have led to relatively high Chinook egg-to-fry survival following a year of high superimposition; perhaps the fry survival would have been even greater?

49 1.8 Uncertainties: Many things stated as "uncertain" apparently in order to downplay degree and importance of uncertainties and sets up argument that any future effects can be conveniently blamed on other factors.

Chapter 2: (See also comments on Appendix A, which largely apply to this Chapter as well):

50 1) On P. 3-7, what is the scientific evidence that as populations become more distinct strays are less likely to successfully reproduce?

51 2) Second paragraph assumes current escapement goals have been met, however escapement has generally been well-below "current escapement goals" and the hatchery's goal is to boost abundance up so that escapement is met as often as possible (in order to have a fishery), therefore the conclusion that there's been no problem under current escapement goals is disingenuous and the "worst case" wasn't really a worst case and may be underestimating straying rates and effects

52 3) The point is made that straying is likely and there will be some decrease in fitness which is claimed to be "insignificant". Please explain why this would be so for a population as small and unique as the beach spawning sockey at Pleasure Point?

53 4) P. 3-13: several bullets discount possible effects on beach spawners using poor or circular logic… but they do wind up concluding appropriately.

54 3.2.3: The main problem here is: 1) the lack of information on sub-population structure and discounting of potential fitness and genetic impacts to small sub-populations that could also lead to cumulative loss of fitness at the population scale, 2) P. 3-22, example of scour effects on 1995 brood year fish and subsequent "successful" hatchery fish spawning is a poor example. We don't really know if those hatchery fish contributed to a decreased level of fitness or not, but based on WCA assessment why wouldn't one assume the subsequent fish were less fit?

P. 3-19 to 3-20

55 Here, the SDEIS acknowledges that the hatchery operation will inevitably remove selective pressures during the whole reproductive phase of the sockeye life cycle for those fish brought into the hatchery. Importantly, mate selection will be unnatural. The associated SDEIS discussion (included above) of consequences of these hatchery shortcomings is inadequate. Consequences of lack of natural mate selection are not discussed at all. Redd-site choice by females involves only one set of traits, among other crucial female reproductive behaviors from which the hatchery will block natural selective pressures. By

55 emphasizing site choice to the exclusion of all other female behaviors vis-a-vis redds, the SDEIS oversimplifies the situation and misleads readers.

Detailed Comments on the draft AMP (DAMP)

P. 1-1

56 The DAMP claims that there is a high potential for successfully implementing adaptive management and uses this high potential as a major safe-guard/justification to allow the hatchery to go forward despite a large number of known impacts and a large number of uncertain, but possible impacts. How has the past decade of operation shown that the likelihood for producing incomparable fish and impacts can actually be avoided? If it is true that this project is applying other experience to this program, why have you not acknowledged the voluminous research showing that hatcheries have long term consequences for the ecosystems in which they are sited? Jim Lichatowich who has consulted on this project has said that supplementation hatcheries should not be used as a long-term solution (Salmon Hatcheries: Past, Present & Future by Jim Lichatowich for the Oregon Business Council and Alder Fork Consulting, February 2001 http://www.orbusinesscouncil.org/docs/hatcheries.pdf. Also see Upstream: Salmon and People in the Northwest, cited in the cover letter.).

The DAMP claims the following two important biological goals for this hatchery program:

57 "1) Implement the Cedar HCP and Landsburg Mitigation Agreement commitments related to a biologically and environmentally sound long-term sockeye hatchery program that will help to provide for the recovery and persistence of a well adapted, genetically diverse, healthy, harvest able population of Cedar River sockeye, and

2) Avoid or reduce detrimental effects on the reproductive fitness and genetic diversity of naturally reproducing salmon populations in the Cedar River and the Lake Washington basin."

Why doesn't the broader river ecosystem get high priority and what are the hatchery's impacts to the river's other biota, especially in the light of the need to recover other species, such as ESA listed Chinook, and the need for much more investment in habitat to satisfy that need. There is no sense that there is responsibility to protect the overall environment.

The DAMP also states the following:

58 "The success of this hatchery program will rely on the ability to integrate artificial and natural production systems to realize the full biological potential of the physical environment. Consequently this AMP focuses on potential risks to naturally spawning salmon, prescribes monitoring activities to detect effects, and

58 establishes a process for analyzing and addressing adverse impacts if they occur. This hatchery program will be deemed a failure if it results in a substantial loss of the ability for naturally reproducing sockeye or Chinook to sustain themselves or if it fails to significantly increase sockeye returns to the Cedar River. The proposed hatchery is expected to augment natural spawning on the Cedar River and, if successful, will produce a greater and more consistent number of returning adult sockeye than would result without it. This is expected to increase sport and tribal harvest opportunities of the Lake Washington sockeye salmon fishery."

This statement brings out the inconsistency of goals: Is the hatchery a supplementation or harvest augmentation hatchery? An augmentation hatchery, as defined by Jim Lichatowich is " ...to increase sport and/or commercial harvest opportunities."

p. 1-2

59 The DAMP notes six objectives. Given that the City failed to conduct the basic SEPA process of assessing the worst case in the first EIS and that it has, and appears to continue to ignore or selectively use data, what guarantee is there that SPU can be trusted to carry out these lofty objectives once the environmental review process is over? Furthermore, the SDEIS says "Success of the AMP will be determined by the achievement of these objectives over time." Please explain how these objectives will be monitored and where there is adequate funding to ensure they will be implemented.

p. 1-4

1.1.4 Key Features of this AMP

60 In this section, the DAMP talks about five major uncertainties. What about effects on the ecology of the river? Do we have certainty about how the river will respond to a major hatchery and its goals? For example, what are conflicts that might arise between managing for ecological processes that sustain Chinook habitat vs. the desire to maintain high-quality, natural spawning conditions for sockeye? In other words, from the perspective of maximizing naturally spawning sockeye (which allows for maximization of the hatchery investment), isn't it desirable to keep the Cedar River as a riffle-dominated system that works well for sockeye spawning, but that is sub-par for chinook?

61 The DAMP says that "This structure [of the AMP] is intended to allow the development of sound scientific direction that will help the decision-makers to manage the hatchery program." Shouldn't the AMP require the development of sound scientific direction? Allowing the possibility does not necessarily mean that it will be occur.

62 The DAMP states "To further reduce risk and to reinforce the fact that this program is intended to supplement, not detract from natural production of

sockeye in the Cedar River, a unique goal of this hatchery is to adjust egg collection goals so that over time and after an initial start up period..."

62 Please describe results and lessons learned from past 12-year startup period? What are the results during that period? Where are they documented in the SDEIS? If they are not documented, it makes a mockery of the claim of adaptive management. Also, is this hatchery truly a supplementation hatchery or a harvest augmentation hatchery and how can both be compatible?

63 The SDEIS focuses on having no more than 50% of total spawning run size being composed of hatchery fish but makes no assessment of the risk of aiming for that proportion (other than it's better than having more than 50% hatchery fish in the population) or why that level of risk is acceptable as opposed to a lesser proportion (say 10% or 25%) of hatchery fish on the spawning grounds. How was a precautionary approach (not only for sockeye population health, but also for Chinook recovery and larger river and lake ecosystem needs) used in setting this ratio? If as is stated later in section 2.1.3 (unknowns), the effects of a 50% ratio of hatchery to wild are unknown, wouldn't it be better to first start with a much lower ratio to incrementally examine effects over the long term. This was the intended approach of the original set of adaptive management studies (i.e., to start small), lessons which continue to be downplayed or ignored.

1.1.5 AMP Implementation

64 Here and throughout the document, the SDEIS frequently invokes the use of monitoring as if it were in and of itself an effective tool for mitigating impacts. However, specificity is lacking in what will be monitored and how and whether there is truly adequate funding to implement the level of monitoring to support the touted AMP. Also recognize that while monitoring collects data it does not give the responsibility to be insightful about use of those data. This has been a perpetual problem in recent decades. How will the responsibility to collect adequate data and then use it responsibly be ensured, especially in light of the history of this project which has consistently ignored data and down or under-played data on possible impacts. Why, after a 12-year pre-operation period, have these issues not already been carefully worked out?

P. 1-9

65 Again, it is noted that after over 12 years of operating and studying the hatchery we still have no preliminary results and no carefully framed plan. How can this be?

p. 2-5

2.1.3 Remaining Unknowns

66 What mixture of natural and hatchery production is adequate to maintain ecological integrity of the Cedar River population?

67 A major problem with the SDEIS is that it fails to adequately define "the Cedar River population" and connect the population-level issues to larger river and lake ecosystem responses, leading to a limited, narrow and reductionist view of issues and effects. What is the justification of that? How does such a narrow perspective comply wtih the mandate of the Clean Water Act (CWA) which implicitly takes on a broader and more comprehensive perspective.

p. 2-6

2.1.4 Hypotheses

68 Why is a 50% hatchery:wild fish proportion, as opposed to a lower proportion of hatchery fish, an acceptable proportion knowing that impacts are already occurring, that the Cedar R. Chinook are in desperate straits and given all of the other uncertainties associated with the hatchery? Why isn't the AMP addressing this basic assumption? Why aren't AMP questions and assumptions themselves subject to peer review?

P.2-8 Budget

69 Please describe where money will come from should 1) the proposed studies cost more than anticipated, 2) additional studies are needed, or 3) more funds are needed to mitigate for effects identified in the future? Also, how will funding be ensured for elements that rely on other agencies' budgets?

P. 2-32

70 Figure 2-3. Average Historical Spawning Curves for Chinook and Sockeye Salmon in the Cedar River (Cascade Environmental Services 1995). This graph uses averages, which may hide subtle yet important information. What has been found about the nature of year to year and seasonal variations? Have those been studied in detail rather than relying on yearly averages?.

P. 2-37

71 2.5 UNCERTAINTY NO. 5—WILL INCREASED HATCHERY PRODUCTION ALTER AQUATIC COMMUNITY STRUCTURE WITHIN THE LAKE WASHINGTON SYSTEM?

2.5.1 Definition and Importance

Why is the river's community structure not also considered an uncertainty?

P.3-5

Table 3-1

72 Why are there are not specific action thresholds defined here?

P. 4-2

The SDEIS sates that

"A proven model for successful adaptive management is for individuals with knowledge and commitment to the success of a program to work together in an open, transparent, agreed-upon structure." and that "The management decisions need to be developed in a public process that has the benefit of comprehensive technical information and input from interested parties."

73 Yet it appears that the scientific work is being performed and ultimately acted upon by a limited set of individuals (researchers and agency staff) or agencies who mostly are either heavily committed to the project or beholden to it for research dollars. Further, there appears to be little or no incentive or opportunity for public review and input. How will the City avoid bias that results from having an insufficient independent review and public input process for a project of this level of concern? How will the bias of those collecting and synthesizing data and ultimately making decisions in the AMP and LMA be off-set? What about experts in river ecology and related subjects, less constrained by their allegiance to specific technologies or fishery harvest commodity goals? What about requiring an annual review by a truly independent professional board (perhaps selected by a professional scientific society)?

P. 4-4

4.2.6 King County

74 What about the responsibility of the Department of Ecology with respect to water quality and the broader goal of the CWA? Why are they not included here?

P. 4-5

4.2.10 The Science Panel

75 Why did the City select its own science review panel and not use a process to minimize the appearance of conflict of interests? Also, what about expertise in the larger, non-salmonid aspects of river ecology? Overall, while many fine scientists were included on the Panel it appears many are also highly desirous of the project's implementation either because of personal or agency desires or availability of research dollars.

Lichatowich on Supplementation.

76 http://www.orbusinesscouncil.org/docs/hatcheries.pdf

Supplementation

76 The generally accepted definition of supplementation was developed by the Regional Assessment of Supplementation Project (RASP): "Supplementation is the use of artificial propagation in the attempt to maintain or increase natural production while maintaining the long-term fitness of the target population, and keeping the ecological and genetic impacts on non-target populations within specified biological limits" (RASP 1992). Supplementation hatcheries attempt to increase natural production. The use of supplementation assumes that the problem that caused reduced production in the target stock has been corrected and that the natural habitat is capable of producing more fish. Supplementation projects should be temporary, terminating after natural production has increased.

Comments on the Worst Case Analysis Workshop Summaries

General observations:

77 1) Many of the scientists do not appear to be independent observers/commenters because they or their agencies are known supporters of this particular hatchery (or of hatcheries in general) or are receiving significant funds from the City for HCP-related research. The City has a track record of using funds to get support for its positions.

78 2) Who determined (and how) the issues to be evaluated for worst case? Why weren't other issues (such as weir effects and impacts to river ecology) not included?

79 3) How was the precautionary principle/approach (as generally advocated in best available science and in ESA guidelines) used in assessing worst case?

80 4) Aside from time taken to set-up meetings and write summaries, it appears the sum-total of technical input for this and the other issues occurred on just one day and presumably each session was concluded in far less than an eight-hour day. This is inadequate to fully vet and assess such complex issues. In some instances, the logic trains and conclusions reflect this limitation.

81 5) No discussion of worst case effects for the river ecology or weir operation (both issues were raised in the SEPA appeal)

Genetics Issues

82 P. 1: Last sentence of the opening paragraph alludes that domestication is only a "might effect" when in fact the science experts all appear to conclude that it will.

83 P. 2/¶ 3: The baseline for fitness is not clear, defines fitness as "the ability of naturally spawning fish to produce offspring that survive to successfully

83 reproduce." Does this mean a naturally spawned fish with or without any recent history of hatchery supplementation? How was the operation of the existing temporary hatchery, which has been releasing significant numbers of fry since 1992 (and which according to Fresh, et al, (2003) has already produced significant effects in just one generation?), factored into the analysis? If assume the baseline starts "today" (e.g., 2005), then effects and lessons learned from the ongoing experiment (see fresh et al 2003 for explanation) are neglected!

84 P. 2, ¶ 3 : Given that the effects of straying on Bear creek fish have been raised as a concern for many years, why hasn't more effort been put into developing a fitness profile for Bear creek sockeye (and beach spawners as well)? Why has the City consistently avoided doing the necessary work to establish a proper baseline? Given this track record, what are the assurances that money or political interest will be sufficient to do so in the future?

85 P. 3, ¶ 2: Suggests that existing sockeye are exhibiting high degree of differentiation and therefore homogenization is not a problem. Absolutely no analysis or data are provided to substantiate that statement. What information did the panel use to make an assessment of how the number of sub-populations? Recall that in the SEPA appeals hearings the City's experts (including Dr. Quinn) seemed unaware of the diversity (although the City consistently wants to downplay that diversity) of the Cedar River's habitats and how sockeye use them.

Straying effects on Bear creek

86 This analysis was hard to follow because it doesn't stick to the issue of Bear creek effects. Instead it mixes up homogenization/domestication issues in the Cedar River with effects of swamping genetic structure of Bear creek population.

87 P. 3, ¶ 3: It appears this is the wrong date for the most recent Fresh report (2003 not 2001). But more importantly, why did the worst case analysis selectively use the Fresh report information to support their conclusion here but not use the differences in wild and hatchery size to refute or clarify conclusions later?

88 P. 3, ¶3: Analysis of straying effects uses an inadequate abundance baseline. No analysis of likely straying effects under a much increased sockeye population, which is, after all, the goal of the hatchery.

89 P3, ¶3: How did the group conclude that the small effect coefficients for the Cedar population wouldn't translate to large effects on a small population?

90 P. 4, ¶1: In this paragraph, the views of two scientists are discounted because they expressed concern that either an AMP would not be in place or that a river release strategy would not be followed. In fact, they may be closer to the truth given past history of a) not using (or waiting to distill) information from the existing ongoing adaptive management experiment, and b) hatchery managers

90 releasing fry as low in river as possible to avoid in-river mortality. We suggest the views of these scientists should not have been dismissed or discounted.

91 P.5, ¶ 2: Opening sentence is confusing. Is the panel recommending to the City that it measure changes in both reproductive success and gene frequencies as indicators of impact?

Straying effects on Lake Washing Beach Spawning Sockeye

92 P.6, ¶ 1: Appears that some or most of the scientists conclude that either beach population is not independent or it's not very important, given that they conclude that the effect of straying would be less or even inconsequential on the beach fish despite their vastly smaller population size (confusion over this may explain the lower degree of agreement)? Please describe how the scientists viewed the fish and provide more detail why they discount effects of straying on them.

Straying effects - General conclusions

93 The four general conclusions are not well-founded because: 1) the only empirical evidence was from a report the City itself has criticized for inadequate statistical design and the data are from years when sockeye are far less abundant than they are projected to be under sustained, full operation of the hatchery; 2) the Cedar River is in fact relatively close to the beach spawning site of Pleasure Point (and it may be the beach spawning populations is the smallest, rarest and most sensitive of all populations to straying effects); and 3) no indication of a precautionary approach in assessing risk.

94 P.6, ¶ 3: Given that the Fresh report collected data when Cedar River sockeye are far less abundant then are projected to be under sustained, full hatchery production, how did the committee extrapolate effects into the future when the hatchery is fully revved up and many, many more sockeye are expected to be present (as per expectations of the hatchery developers) and presumably straying rates would go up commensurately? What precautionary approach/information did the scientist make when making their conclusions in this regard?

95 P.6, ¶ 3: The scientists put great emphasis on data in the Fresh report, yet the City is on record as having criticized the otolith collection statistical design (Skalski) when the report concluded differences had arisen between wild and hatchery fry in just one generation. Did the scientists review the data to be sure it was of sufficient quality to be used in this manner? If so, what did it conclude and why? If not, then how did it justify relying so heavily on the report? What level of confidence in the data was used to justify the conclusions?

Homogenization of Population Structure

96 Under Homogenization, the reluctant assumption that the Cedar River has become genetically structured within 70 years is too hesitant given evidence of

96 spatial and temporal structuring reported in recently-colonized sockeye populations in Lake Clark, Alaska (Ramstad et al. 2004, Molecular Ecology 13:277-290). The claim that "..homogenization by the hatchery might retard or halt such evolution..." doesn't include reduction of existing structure, an inevitable effect of homogenization. Finally, since fitness appears to be based on total natural recruitment, the variable fitness values that would occur within a structured population are not considered. Thus loss of productivity of ephemeral (and most likely unknown) but important spatial or temporal subgroups would remain undetected. The panel appears to acknowledge the importance of such variability in the final paragraph of this section, but fails to adequately deal with its assessment.

97 Generally this section and its conclusion (i.e., homogenization is highly likely to occur) makes sense. The scientists seemed aware of the lack of even the most basic knowledge about sockeye population structure within the Cedar River or even if there is a population sub-structure! Shouldn't the lack of this most basic information after so many years of planning give us pause to question whether we know enough about the population to be subjecting them to large-scale tinkering with a hatchery? Again, the main concern is whether the scientists had enough information, or in the face of uncertainty, were sufficiently precautionary in their conclusions. The question is: how did uncertainty factor into their conclusions about effects and what about the conclusions is precautionary?

Domestication

98 This section concludes there is a high likelihood of domestication and reduction in fitness as high as 20%. Here again, it's not clear how precautionary the assessments are (in favor of preventing domestication effects).

Additional Considerations

99 Limitations noted in the process point to sloppiness on part of the City in setting up the workshop and in allowing adequate time for scientists to hear and synthesize information. Scientists were not given basic baseline information (assumptions, common knowledge of the system and hatchery operations, past problems, etc.) to be sure all were on "the same page." Also, there was an acknowledged arbitrariness and "spur of the moment" aspect to the assessment and a lack of integration of all effects, thus synergistic complications were not assessed. In all, while often a good effort, much more could have been done to make this a more valuable and helpful effort.

Predation-Competition Report

Response variables

100 How were uncertainty and a precautionary approach – especially given the difficulty in measuring the response variables – factored into subsequent analysis?

General assumptions

101 There are no explicit assumptions about cumulative effects across two or more years. For example, how was the sustained, high cropping effect on zooplankton (changes in size, species, overall quality of food base) that would result from a very high sockeye fry population in one year or more continuous years factored into quantity and quality of the food supply the following year (or years)? Also, as an alternative to concluding that food isn't a problem in Lake Washington because it produces such large smolts, why couldn't an alternative argument be that food is limiting, and only big fish survive to become smolts. When combined with Lake Washington's relatively warm water those fish that do find adequate food are also in an environment good temperatures for growth, this would conspire to produce an illusion of good food supply when in fact it isn't so good.

Spawning Ground Interactions

102 The selection of only a small group of scientists, at least some of whom may be biased by historic agency and personal views on the project, seems deficient. What were the criteria for picking this group?

103 The section on competition is especially problematic. Assumptions and discussion use ill-defined descriptions and are largely a string of opinions stated as fact and unsupported by quantitative data or literature. This section also provides much less discussion of issues and how choices were made than other WCA sections.

Background

104 P. 1: Background information says the hatchery was established in the late 1990s. This is incorrect; smolts were released starting in 1992.

105 P. 3: What empirical data or literature supports the basic assumption that Chinook dominate behaviorally on the spawning ground (a conclusion not shared by all biologists who've observed sockeye and Chinook interactions on the Cedar River)? If they dominate (and, as is stated later on, sockeye don't dig up their redds), then why do they bother moving at all?

106 P. 3: What empirical data or literature supports the basic assumptions that Chinook leave their preferred area under low sockeye abundance and go to equally good areas for spawning under high sockeye abundance? Have Chinook spawning sites under high and low sockeye abundance actually been assessed for differences in substrate quality, susceptibility to scour and other variables? If so, please provide data. If not, what actual observations have led to the conclusion and why, after so many years, has not even this base level of information been collected? What quantification has actually been made since the issue of sockeye/Chinook interactions became apparent some ten years ago?

107 P. 3: What empirical data or literature supports the basic assumption that energy expenditure by Chinook during interactions with sockeye is not extensive? What is meant by "not extensive" and how much would it take to be extensive enough to make a difference? Assumption (f) says the only exception might be when a Chinook is surrounded by "sheer numbers" of sockeye. How many sockeye does it take to be considered "sheer" and aren't sockeye generally considered "mass spawners" and as such aren't they typically found in large (i.e., "sheer") numbers on the spawning ground?

108 P. 3: What empirical data or literature supports the basic assumptions that Chinook are actually spawning in deeper water and that their redds are no more susceptible to scour than in areas they would select in the absence of high numbers of sockeye?

109 P. 3: Given that Chinook are native and listed under the federal ESA, how was the precautionary principle (as required under the ESA) used in making these determinations? What literature or data suggest that a sustained, two-fold increase in sockeye abundance will have no effect on Chinook spawning success?

110 P. 5: One of the conclusion statements is that Chinook use sites (for spawning) not directly comparable to sockeye. If this is so, then why do they move from places they would have otherwise spawned in under low sockeye abundance?

111 P. 6: Summary: Are there no other factors that could have led to relatively high Chinook survival even under high sockeye spawner abundance? How were other environmental stochastic factors considered in this conclusion?

Conclusion:

After reviewing the SDEIS (and additional information it ignored or downplayed), we conclude that the most likely long-term effects of the hatchery are:

1. A less-fit, less-productive, homogenized run of sockeye;

2. Serious and costly hindrance or out-right block on Chinook recovery; and

112 3. Many hidden future costs and unintended consequences relative to habitat-based mitigation measures.

The latter problem – due to serious under funding of AMP needs – will divert available money for WRIA 8 Chinook (and other native fish) recovery needs, adding to existing funding concerns. Habitat-based means protection and restoration of floodplains, estuaries, riparian corridors and upland forests, which are the broad goals of the WRIA 8 projects, as opposed to simple construction of side channels, additions of LWD, and stormwater treatments that only a single-

112 species or a single aspect of an ecological process, such as peak storm flows but not storm flow duration.

Responses to Comment Letter TT (Toby Thaler)

TT-1. Comment noted.

TT-2. The comment addresses an issue that is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please refer to General Response No. 1.

TT-3. Please refer to General Response No. 3 and Section 1.6 of the SEIS.

TT-4. The term "precautionary principle" can be interpreted to have a wide variety of meanings. There is no single accepted interpretation. There is no interpretation of the precautionary principle under SEPA, nor is there a legal requirement to incorporate this principle into SEPA analyses. Therefore, the worst case analysis prepared for this SEIS did not directly incorporate the precautionary principle. (See FSEIS Section 1.6.1 for a discussion of the guidance available for constructing a worst case analysis.)

Generally, the term "precautionary principle" is an approach to dealing with decision-making in the face of uncertainty, with the overall intent to reduce risk to the environment.

While the precautionary principle was not directly applied to the worst case analysis, the intent to reduce risk in the face of uncertainty is applied to the AMP in the following manner:

- The AMP identifies key uncertainties and focuses monitoring on these potential effects so that they can be detected and addressed, if necessary;
- The AMP is designed to reduce the risk of significant irreversible effects;
- Flexible production levels allow the AMP process to adjust hatchery production to be compatible with minimizing potential effects on species and to respond to environmental constraints; and
- The AMP identifies financial commitments for implementation.

In addition, through operation of the interim hatchery, SPU has identified some limitations in the present facility that are being addressed in design of the replacement hatchery. These changes will result in a better match with the timing and development of natural origin fry. Overall, the hatchery has adopted conservative, precautionary operating protocols to minimize or avoid hatchery effects.

TT-5. The commenter is correct that both of these issues were raised in the SEPA appeal. However, the worst case analyses focused on those issues identified in the Hearing Examiner's decision as needing further examination and did not include a re-evaluation of issues considered by the Hearing Examiner but not identified as needing additional evaluation. See General Response No. 1.

TT-6. This comment addresses the City's policy decision to implement an AMP and is not a focus of this SEIS. The scope of this SEIS includes those issues that the Hearing Examiner's decision directed SPU to further develop. See General Response No. 1.

TT-7. SPU assumes that the "otolith studies" refers primarily to the recently published report by Fresh et al. (2003). The five hypotheses listed in Section 2.1.4. of the AMP include:

Hypothesis 1: There is no difference in migration timing between hatchery and naturally produced fry.

Response: The report by Fresh et al. (2003) refers to data collected by WDFW and published in annual reports that compare outmigration timing between hatchery and natural fry. The differences in fry timing are likely due to differences in incubation temperature between river water (affecting natural fry development) and spring water (affecting hatchery fry development) as well as to differences in broodstock collection timing compared to the overall spawning timing of the run. The replacement hatchery would provide a heat exchanger to alter spring water temperature to approximate that of the river water, and the new broodstock collection facility would enhance the opportunity to collect broodstock later in the run, to better match overall run timing. Rather than demonstrate that the goal of similar fry timing cannot be achieved, results of the interim hatchery have shown what must be incorporated into the design of the replacement hatchery to eliminate those constraints that can be controlled.

Hypothesis 2: At the time of emergence, there is no difference in size of hatchery and naturally produced fry.

Response: The Fresh et al. (2003) report did not address this hypothesis.

Hypothesis 3: The average proportion of hatchery fry in the Cedar River sockeye population does not significantly exceed 50 percent.

Response: While the Fresh et al. (2003) report does not address this hypothesis directly by estimating the numbers of returns by origin, the ratios of hatchery to natural origin adults indicated in Tables 10 and 11 suggest that hatchery returns have been less than 50 percent of the return. This has been supported by analysis of samples of adults collected during sport fisheries, that indicate that hatchery returns make up roughly 20-25 percent of the sockeye catch.

Hypothesis 4: At the time of the pre-smolt surveys, there is no difference in size of hatchery and naturally produced fry.

Response: The Fresh et al. (2003) report did not include pre-smolt data to allow evaluation of this hypothesis. Information from smolts collected in 2004 did show that unfed sockeye fry from early releases grew larger than those hatchery fry from the middle and late period releases and natural origin fry, suggesting that the timing difference discussed under the first hypothesis has ramifications to smolt size. Based on these limited results, aligning timing might be expected to align size of the smolts.

Hypothesis 5: At the time of pre-smolt surveys, the proportions of hatchery and naturally produced sockeye do not differ from those that entered the lake as fry.

Response: The Fresh et al. (2003) report did not include data needed to evaluate this hypothesis.

Results from the interim hatchery are not necessarily predictive of those for the replacement hatchery.

As information continues to become available from WDFW, SPU and others, it will be tested against the hypotheses listed in Section 2.1.4, and incorporated into the management program for the replacement hatchery. This will include information about differences in the size of hatchery and naturally produced fry, both at the time of emergence and at the time of pre-smolt surveys, and annual estimates of the average proportion of hatchery fry in the Cedar River.

TT-8. Quantifiable thresholds have been added to the AMP (see various discussions in Section 2 of the AMP). These thresholds will continue to undergo further technical review prior to implementing the AMP, as noted in Table 4-1 of the AMP.

Sections 3 and 4.8 of the AMP describe the review process and the roles of those involved if a threshold is exceeded.

The second aspect of the comment is related to how the AMP was considered for the worst case analysis. The worst case scenarios were evaluated using a base assumption that there would be no AMP, thereby identifying worst case impacts. Generally, specific components of the AMP were not considered in the worst case analysis because the AMP is intended as a mechanism to avoid or minimize impacts from the proposed hatchery, and therefore, actions undertaken as part of the AMP would result in conditions that were not "worst case." A discussion of how the AMP would address uncertainty identified by the worst case analysis is included in Chapter 3 of the SEIS as related to genetic impacts (Section 3.2.6), predation (Section 3.3.4), food supply and competition (Section 3.4.4), spawning ground competition (Section 3.5.4), and superimposition (Section 3.6.3) and superimposition (Section 3.6.3).

Additional discussion of funding for the AMP is included in General Response No. 5.

TT-9. In developing the AMP, SPU considered a variety of possible methodologies and approaches, and ultimately developed a program tailored to the unique circumstances associated with the proposed replacement hatchery. See FSEIS Sections 2.2.1 through 2.2.3 and AMP Section 1.1.3. See also General Response No. 4.

The City has committed funding for the AMP for over 50 years, as described on p. 5.3-6 of the HCP. See also SEIS Section 2.6 and General Response No. 5.

TT-10. The Forest and Fish Report (FFR), referred to by the commenter, describes "performance targets" which are *"the measurable criteria defining specific, attainable target forest conditions and processes"*. The AMP has been developed to

avoid or minimize adverse effects as described in Section 1 of the AMP. The quantifiable thresholds, which are measurable, perform the function of the measurable criteria of the FFR in that they provide benchmarks. Benchmarks reflect the goals of the program and may be structured in terms of achieving a positive outcome or avoiding an undesirable impact. In the case of the replacement hatchery, the thresholds identify a level of change that indicates a need for review and possible action. In the case of the FFR, it is the attainment of an environmental condition thought to be supportive of aquatic health, and hence the health of fish.

The thresholds in the AMP will undergo further review prior to implementation as noted in Table 4-1 of the AMP. Refer to General Response No. 4 and to Response 8 of this letter for additional discussion.

TT-11. Figure 4-1 in the AMP identifies the proposed AMP participant relationships.

Section 2.7.2 of the SEIS and Section 4.4.3 of the AMP identify how the members of the Technical Work Group will be selected: "These appointees will be selected by the parties to the LMA [NOAA Fisheres, USFWS, the City of Seattle, and WDFW] in consultation with the AMWG" [Adaptive Management Work Group]. Independent scientists will be used to encourage objective evaluation and advice. Regarding the selection of the Technical Work Group, the AMP further states:

> "It is proposed that the membership of the TWG be recruited from federal and state agencies, tribal organizations, universities, or private practice based primarily on the technical expertise needed and the commitment of candidates to sound resource stewardship. In addition to technical capability, potential members will be evaluated on their ability to work as part of a group and on their interest and ability to clearly communicate scientific information to managers and decision-makers. Members will be appointed on staggered terms" (AMP Section 4.4.3). The AMP specifies that "Candidates will not be chosen on the basis of representation of specific organizations or agencies."

TT-12. Please see General Response No. 2.

TT-13. The HCP makes a 50-year funding commitment toward adaptive management for the Cedar River Hatchery. The Seattle City Council has committed to funding the HCP, and the AMP as a part of the HCP. Please see General Response No. 5.

The AMP describes a peer review process; see Sections 4.4.2 through 4.4.4 for a description of the Technical Work Group and the Independent Science Advisors. In addition, work done under the AMP will lead to publication of papers in peer-reviewed journals.

TT-14. Comment noted. Responses are provided in this comment response document and, where appropriate, text has been modified in the SEIS.

TT-15. Please see General Response No. 6.

Potential adverse interactions between sockeye and Chinook have been assessed in this SEIS as part of the worst case analysis to supplement evaluations provided in previous environmental review documents.

The AMP is a program to detect impacts, should they arise, and to make management adjustments to minimize such impacts. Funding for the AMP has been previously discussed in Response 13 of this letter and in General Response No. 5.

TT-16. The schedule for implementation of the AMP is shown in Section 2.4 of the SEIS and Table 4-1 of the AMP. The City is currently funding monitoring and is committed to augmenting the current monitoring efforts when the AMP is implemented. The design of the monitoring program will be finalized following completion of the review process for the hatchery, as stipulated in the LMA.

Refer to General Response No. 5 and to Response 13 of this letter for a discussion of the City's commitment to funding.

TT-17. Refer to General Response No. 2.

As more of the Lake Washington research being conducted by others is published, it will continue to be incorporated in decisions regarding the proposed hatchery.

The structure of the AMP should facilitate access to data resulting from research conducted under the plan. The AMP should encourage timely production of reports and robust discussion of study plans and analysis of results.

TT-18. Regarding legal authority for construction of the hatchery and comments concerning compliance with state law, please see General Response No. 1.

TT-19. This comment addresses the question of whether or not the construction of the hatchery is a wise public policy decision. While that is an appropriate question for decision-makers, it is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please see General Response No. 1.

Please also see General Response No. 6, Response 15 of this letter, and Section 4.4 of the HCP EA/EIS.

TT-20. The City has not changed its position that the Cedar River Sockeye Hatchery is for sockeye and has no plans to use the facility for other species.

TT-21. These comments are not directly related to the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please refer to General Response No. 1.

The commenter mischaracterizes the comments of the Puget Sound Technical Recovery Team (TRT), an advisory group to NOAA Fisheries, addressing concerns about the scope of the WRIA 8 draft recovery plan. Written comments from the TRT

(November 16, 2004) indicate that the group had questions concerning the lack of integration of habitat work with hatchery and harvest strategies in the draft WRIA 8 plan. The discussion of critical threats to Chinook in the TRT comments notes *10* areas of concern [emphasis added] by the TRT (p. 8), and they, noted that, "Habitat loss seems to be the most significant threat facing the population."

The TRT comments continue: "The threats are listed [in the plan]: Altered hydrology, loss of floodplain connectivity, lack of riparian vegetation, disrupted sediment processes, loss of shoreline complexity, barriers to migration. Other threats discussed are water quality, effects of hatchery strays on natural origin recruits, and land use changes that seem to underlie habitat degradation. *One* (emphasis added) reviewer suggests two other critical threats: the Cedar River sockeye hatchery, and the demographic threat posed by the low population size of the Cedar Chinook population." (November 16, 2004 Technical Feedback – Lake Washington/Cedar/Sammamish)

The TRT comments on the draft WRIA 8 plan do not indicate that the TRT as a group identified the sockeye hatchery as a major risk factor to Chinook recovery.

Please also refer to General Response No. 6 and Response 15 of this letter.

TT-22. Comment noted. This comment addresses an issue that is not directly related to the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please refer to General Response No. 1.

This comment was provided to Mary Ruckleshaus, chair of the TRT. Her response was: "We do not say anything about priorities for particular populations and what ultimate status they will achieve in our criteria." (e-mail to Judith Noble, June 9, 2005).

TT-23. Studies are continuing to develop and provide insight on the effects of hatcheries and hatchery management. The FEIS acknowledges the uncertainty over potential hatchery effects so that these may be adequately disclosed to decision-makers. Please refer to Sections 4.3, 13-19, 28-30; and 4.6-110-112,130 of the HCP; Section 4.4.2 of the HCP EA/EIS; HCP Technical Appendix 29; and NMFS Biological Opinion Section VI.B.4.c.

In addition, Section 3.2 of the SEIS responds to the Hearing Examiner's request to develop a worst case analysis for further discussion of risks and potential hatchery effects. The AMP provides a way to continue to monitor and respond to the potential for risk.

Because this is an important and difficult area, SPU has provided additional language in Section 3.2.4.3 of the FSEIS and has added an additional appendix, Appendix C, in part 1 of this FSEIS, which surveys relevant scientific information.

It is important to note that the article in *Science* was related to a NOAA Fisheries decision to alter its hatchery policy as a result of *Alsea Valley Alliance v. Evans*.

This specifically addressed the reasonableness of including hatchery produced fish in the ESU when considering ESA listings, and so is only of limited relevance to the specific issues at hand. We are unable to respond to the commenter's remark about an internal memo as it was not identified nor provided to us with the comment letter.

TT-24. Comment noted. Please refer to General Response No. 6 and Response 19 of this letter.

TT-25. The comment addresses an issue that is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please see General Response No. 1.

See Sections 2.4.3 and 2.4.4 in the FEIS for a discussion of the effects of the construction of broodstock collection facilities and their operation.

TT-26. The final report, *Evaluation of the Cedar River Sockeye Salmon Hatchery: Analyses of Adult Otolith Recoveries*, was recently released by WDFW, although the report is dated January 2003. The report finds several differences between hatchery and natural origin sockeye, including some differences in the size of females, spatial spawning distribution, and timing of broodstock collection relative to overall run timing. The report cites potential remedies for all of these effects; however, there is uncertainty that the remedies will be successful in avoiding these or other effects. The SEIS discloses this uncertainty in its worst case analysis to provide decision-makers with reasonable information on which to make their decision regarding the project. The preliminary version of this report is discussed in the FEIS and responses to comments (e.g. see FEIS p. S-34, pp. 2.4-6, 2.4-33-34; and Response to Comments to the Draft EIS, pp. A5-A8). The findings of the Fresh report are included in the discussion of hatchery effects on fitness contained in Appendix C.

TT-27. See General Response No. 2. The commenter is mistaken in assuming that the interim hatchery was part of an adaptive management plan. A footnote has been added to the AMP, Section 1, to clarify that the AMP supports the replacement hatchery.

TT-28. The commenter makes a legal argument that is outside the scope of this SEIS as established by the Hearing Examiner: to conduct worst case analyses on specified topics and to further discuss the AMP. See General Response No. 1.

See also Letter TT, Response 23 concerning fitness issues.

TT-29. See General Response No. 2 concerning availability and use of data. No adaptive management process has been implemented for the interim hatchery. See Response 27 of this letter.

The commenter may be confused about two different reports by Fresh. Seattle Public Utilities has not criticized the Fresh et al. (2001) report that analyzes Bear Creek strays. Fresh et al. (2001) described the results of otolith sampling in Bear Creek in 1998, 1999 and 2000 for the purposes of evaluating straying from the hatchery to

Bear Creek. Information from the Fresh et al. (2001) report was used to evaluate the worst case analysis of straying to Bear Creek.

Fresh et al. (2003), first released as a draft in 2002, analyzes otolith data collected in the Cedar River from 1995 through 2000 and compares hatchery and natural origin returns with respect to time of return, spawning distribution, size and age at maturity. Sampling and analytical methods associated with the draft Fresh et al. report (2002) were reviewed by Dr. John Skalski of the University of Washington at the request of the Cedar River Anadromous Fish Committee and with the cooperation of two of the authors and other WDFW staff. Dr. Skalski's review indicated that certain analyses in the draft report would be unreliable due to sampling methodology. Authors of the report agreed with this assessment and modified the final version of the report (Fresh et al., 2003, released in 2005).

Information from the recently released Fresh et al. (2003) report has been added to the AMP. Several of the scientists on the genetics panel for worst case analysis had reviewed the draft otolith report (2002); one was a co-author.

At the time that the worst case analysis was being done, the Fresh et al. (2003) report was undergoing further WDFW review and the final version had not been released. However, results on hatchery spawner distribution, which are included in the final report, were considered in the discussion of homogenization by the group of scientists when they met to consider genetic effects.

Fresh et al. (2003) found differences in some comparisons between hatchery and natural origin females and other measures. The final report points to some differences in size of females of the same age, timing of collection of broodstock and temporal and spatial spawning distribution of adults attributable to the hatchery. Differences in size, based on the 2002 draft, were discussed in the FEIS (pp. 2.4-33-34; Appendix A, pp. A-5-8). Language has been added to the FSEIS referring to these findings. See Section 3.2.4.1 and Appendix C. The potential for differences in run timing were identified in the FEIS (p.2.4-32) and further discussion of these differences has been added to the SEIS, Section 3.2.4.1. Potential differences in spawning distribution were identified in the FEIS (p. 2.4-38). Subsequent information from Fresh et al. (2003) that discusses differences in spawning distribution between hatchery and natural origin returns has been added to the FSEIS Section 3.2.3.1. These effects were considered in the development of the worst case analysis.

Facility improvements proposed for the replacement hatchery are intended to address the differences in timing of fry outmigration and will more closely align the collection of broodstock with the overall run timing. However, these changes may not eliminate all differences between hatchery and natural origin sockeye in the Cedar River.

As described in Section 1.7.2 of the SEIS, spawning distribution will likely be different between hatchery and natural origin returns, resulting in a high probability

of homogenization under a worst case scenario. This finding was based on the assumption that there is some subpopulation structure in the Cedar River. There are no data to confirm this assumption, and there are differing views on the level of differentiation that may exist. The FEIS (p. 2.4-38) discusses findings in the draft Fresh et al. report, noting that hatchery release practices could result in differences between hatchery and natural origin returns, leading to mixing of fish throughout the river. This mixing would obscure subpopulation structure based on spatial differences.

The level of impact of homogenization on the reproductive fitness of the sockeye population is uncertain. The Cedar River sockeye population displays an unusually long run timing (4 to 5 months) and stream life is estimated at about 2 weeks, making it unlikely that fish of different run timing will interbreed either in the hatchery or in the natural environment. Therefore, subpopulation structure based on temporal separation would be less likely to change significantly.

Some scientists believe that the Cedar River includes substantial habitat diversity and that this would be expected to create subpopulation structure that would be lost through homogenization. However, Hall and Wissmar (2004) describe the Cedar River as "an altered river system with limited habitat types" and describe the changes that have made the river more uniform habitat than it was historically.

TT-30. Each one of these issues is discussed throughout the SEIS and addressed by the worst case analysis. (1) Section 3.4 of the SEIS concludes that food in Lake Washington is sufficient and that sockeye fry do not represent a large enough mass of consumers in the lake, even under the worst case scenario, to significantly affect the forage base. (2) Section 3.6 of the SEIS concludes that it is highly unlikely that sockeye would directly harm significant numbers of Chinook redds (this is density independent—based on the size of the fish). (3) The SEIS also discusses competition for spawning sites and concludes that if Chinook were displaced at all, it would likely be to deeper parts of the river that sockeye do not utilize for spawning but Chinook can use (see Section 3.5 of the SEIS). These areas would be less susceptible to scour and other flow-related impacts. (4) Impacts to nearby native populations are the topic of an extensive discussion in Section 3.2 of the SEIS. Concerns about the effects of sockeye on Chinook due to the number of spawners can be addressed through harvest management by the fishery co-managers. Nevertheless, the assumptions for worst case analysis assumed a spawner goal of at least 300,000.

Even though scientists thought that, for each case, impacts were not likely to be high, and more often that they were likely to be low, the density of juveniles is a complex issue involving many factors. The AMP will provide an opportunity to monitor growth and adjust density (production) if there appear to be problems. In addition, Chinook will be monitored at the adult and juvenile stages so that adjustments can be made in response to possible impacts to that population. Generally, however, it is unlikely that impacts would be significant, and it is expected that such impacts will be detectable and adjustments can be made if impacts are detected.

TT-31. The AMP is being funded to address impacts to Chinook and other species.

Tables in Section 2 of the AMP display costs for specific studies for only the first 8-10 years. Footnote (b) of each table states, "Further studies will be decided through analysis of study results." See Table 5.3.2 of the HCP for the full 50-year funding plan. The HCP is expected to be supported by fees collected from water rates and is not dependent on General Fund revenues. Additional language has been added to the headings of appropriate tables in Section 2 of the AMP to avoid future confusion.

Please see also see General Response No. 5.

Issues regarding habitat mitigation for Chinook recovery are not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please refer to General Response No. 1.

TT-32. This comment presents a legal argument that is not directly related to either the worst case analysis or the description of the AMP. Please see General Response No. 1.

TT-33. The comment addresses issues that are beyond the specific issues that the Hearing Examiner directed must be evaluated as part of the worst case analysis in the SEIS. The Hearing Examiner determined that potential impacts from disease, including IHN, were adequately discussed in the FEIS. Please see Conclusion No. 7 of the Hearing Examiner's decision.

See also Addendum No. 1 FEIS for a discussion of losses to IHN.

TT-34. Comment noted.

In the LMA, the City made specific commitments to construct the hatchery as described in the HCP.

TT-35. Please refer to General Response No. 1 and Response 2 of this letter.

TT-36. Please refer to General Response No. 1 and Response 2 of this letter.

The NMFS has indicated in their SEIS comment letter that "The Worst Case Analysis is consistent with the April 2000 NMFS BiOp and Findings. There are not new substantial affects[sic] identified that would indicate that NMFS should reanalyze anything."

TT-37. The statement is a direct quote from the HCP and is correctly quoted. See HCP 4.3-17.

With regard to beach spawners, Bear Creek and the Cedar River were selected in this objective because they are the most abundant sockeye populations in the Lake Washington basin.

TT-38. This comment addresses an issue that is not directly related to either the worst case analysis or the AMP. Please refer to General Response No. 1.

Please see the HCP EA/EIS for an evaluation of alternatives to the proposed hatchery.

TT-39. Please see General Response No. 5. The City does not assert that funding will be available for every possible research question. The AMP sets up a structure through which resources can be allocated to ensure that the most important questions, as recommended by independent scientists, will be pursued.

TT-40. Refer to General Response No. 3.

TT-41. Comment noted. The text of the SEIS Section 1.6.2.1 has been changed to reflect that the superimposition workshop group chose to use 300,000 spawners in their worst case analysis. This represents the current escapement goal determined by the co-managers and by which they manage harvest.

TT-42. The worst case analysis workshop summaries were submitted for review by the participants in the workshop to ensure that the summaries accurately represented their discussions. Refer to General Response No. 3 for a discussion of the worst case analysis approach and the selection of participants for the workshop. The participants were solely responsible for the conclusions represented in the summaries. The purpose of an EIS is to disclose impacts to decision-makers, and the SEIS discusses impacts from the worst case analysis as required by the Hearing Examiner. The issue of whether or not impacts disclosed in the worst case analysis are "OK" is a policy question to be addressed by decision-makers.

TT-43. The workshop summary provides two potential factors that could limit the population of beach spawning sockeye: shoreline development and harvest. Based on currently available data, it is unclear how shoreline development and the hatchery are linked.

Harvest pressure is likely to increase with higher returns that could result from additional hatchery production. These harvest pressures might be modified by how the fisheries are conducted, but this is uncertain and there is potential for overharvest of beach spawning sockeye (see genetics workshop summary and p. 2.4-38 of the FEIS). It is not accurate to conclude that other problems are indirectly or directly related to the hatchery. Seattle Public Utilities may study the interrelationship of the hatchery and beach spawners through implementation of the AMP, if this issue is considered to be of high priority relative to other uncertainties.

TT-44. This issue is discussed in Appendix B, including the list of all workshop participants and the lead author for the workshop summary. The issue of "which scientist" concluded that homogenization would be a minor effect is not directly relevant to whether the worst case analysis as a whole was a reasonable methodology to adequately discuss potential worst case impacts. Refer to General Response No. 3. A wide range of scientists was included on the distribution list for the SEIS, with ample opportunity for comment on the methodology and conclusions. All comments received are included in the FSEIS.

TT-45. This is discussed in detail in Appendix B of the SEIS. The evaluations conducted as part of the worst case analyses concluded that sockeye were such a small component of the predators' diet that even a doubling of sockeye numbers would not significantly increase the numbers or biomass of predators. As a result, no "overcropping" of food supply is anticipated. The abundance of predators is likely driven by overall prey abundance that is dominated by other species. As prey biomass in total likely changes over time, predator populations may also change in a dynamic system like Lake Washington.

TT-46. In the last sentence, the word "abundance" refers to abundance of prey items. The workshop summary indicates that the panel used the assumption that 80 to 85 million sockeye fry would enter Lake Washington to provide a worst case scenario as directed by the Hearing Examiner's decision. The largest number of sockeye fry leaving the Cedar River recorded to date is about 52 million. Under the worst case analysis, it was assumed that the replacement hatchery would add about 17 million above current hatchery capacity and that this would add to natural production and existing hatchery production. The 80 to 85 million was intended to reflect both high natural production and increased production from the replacement hatchery.

TT-47. The worst case evaluation in the SEIS of the potential effects of superimposition and competition for spawning sites is reasonable and was developed using the best collective judgment of biologists on the panel that evaluated this issue. There is uncertainty regarding the potential effects of spawning ground competition and superimposition, and some differences between scientists would be expected. Refer to General Response No. 3 regarding the worst case analysis process.

It is important to consider that current data do not suggest that Chinook fry production per capita has decreased when sockeye are more abundant. The AMP will monitor Chinook and sockeye numbers to detect these effects, and both harvest rates and hatchery production can be adjusted if there are negative effects.

TT-48. The issue of insufficient gravel depth was not identified as a concern by the workshop participants. The commenter's conclusions are not supported by the experts who participated in the workshop (their findings are included in Appendix B). If sockeye were targeting Chinook redds for spawning, as suggested in this comment, then superimposition of Chinook redds would be expected to be near 100 percent each year because of the ratio of sockeye to Chinook of approximately 100:1. Observations of actual superimposition in the Cedar River average below 100 percent and none of the workshop participants postulated that the level of superimposition would be likely be this high. An exercise assuming 100 percent superimposition was done to examine a worst case scenario.

Seattle Public Utilities agrees that other factors may have contributed to the high survival rate of juvenile Chinook from Brood Year 2002, when the superimposition rate was 88 percent. Text has been added to the SEIS Section 1.7.7, to indicate that other factors may have contributed to the high survival of Chinook in the year when superimposition was also highest.

TT-49. Biological systems are inherently complex and constantly changing. Identifying uncertainties is not an attempt on the part of SPU to downplay the importance of these issues, but to acknowledge and discuss the areas of uncertainty for decision-makers. In accordance with SMC 25.05.080, these areas of uncertainty have been identified, the potential likelihood of occurrence has been estimated, and the potential worst case outcomes have been described.

The evaluation of cause and effect is part of the adaptive management process (see Section 4.8 of the AMP).

TT-50. This statement refers to differences such as differences in spawn timing. Spawn timing is strongly heritable and can isolate fish of different run timings, making interbreeding rare or impossible (Ramstad, K.M., Woody, C.A., Sage, G.K., and Allendorf, F.W. 2004. Founding events influence genetic population structure of sockeye salmon (*Onchorhynchus nerka*) in Lake Clark, Alaska. *Molecular Ecology* 13:277).

Observations on the colonization and differentiation of introduced Chinook to New Zealand rivers provide additional evidence for this statement. (Tom Quinn, personal communication).

TT-51. The commenter's assertion that the second paragraph assumes that current escapement goals are met is incorrect. The worst case analysis described in Section 3.2.2 of the SEIS and Appendix B did take into account a worst case assumption of high hatchery returns. The worst case analysis in Appendix B of the SEIS is based on the maximum rate of straying that could have been occurring without detection. Dr. Quinn's analysis assumed that 180,000 hatchery origin fish were returning to the Cedar River.

TT-52. Please refer to the DSEIS Section 3.2.2.8 for a detailed discussion of the potential effects of straying on beach spawning sockeye populations in Lake Washington, of which Pleasure Point is one. Note that the conclusion of this section states that impacts for the beach spawning population may be "medium to high" not "insignificant."

TT-53. Comment noted.

TT-54. The worst case analysis assumed that subpopulation structure exists and that such structure would contribute to higher population productivity. Refer to the assumptions listed in Section 3.2.3.3 of the SEIS specific to subpopulations.

The worst case analysis also assumed that the loss of such structure would result in a loss of population productivity. The workshop panel estimated the likelihood and magnitude of such losses in their analyses, as described in detail in Appendix B.

With the release of the report by Fresh et al. (2003), it is possible to say that the majority of fish returning in 1999 were likely to have been five-year-olds; thus these fish presumably played a more significant role in the subsequent improvement in fry

production in what had been a weak production year that reoccurred every four years. Normally four-year-olds are more abundant than fives, which was the basis for the observation in the SEIS. This example has been replaced with a different analysis in Part 1 of this FSEIS Section 3.2.4.4.

TT-55. The SEIS includes information on the general consequences of eliminating natural mate selection, including the loss of reproductive fitness, smaller size, and other consequences, to allow the potential range of consequences to be identified.

The SEIS discusses in Section 3.2.4.1 that the removal of selection pressure during reproduction will occur, that this will increase the potential for domestication and that it will inevitably result in effects to the resulting fry that would not occur under natural conditions. The SEIS does not solely focus on redd site selection, but includes this as one example for the purpose of relating this complex topic to the reader. Other impacts related to the removal of selection pressure were considered by the workshop participants, and the discussion of these and their resulting opinions relative to the effect on fitness is included in the evaluation of homogenization and domestication in Appendix B.

Based on this comment and others, additional discussion of potential effects of altering selection pressures during reproduction and early incubation has been added to the SEIS Section 3.2.4.3, and a new appendix, Appendix C, has been added to Part 1 of this FSEIS.

TT-56. Monitoring and operating results from the existing hatchery are being used to guide current operations and design of the replacement hatchery. The current interim hatchery has not operated under an AMP, nor does it have the capacity for evaluating and implementing management adjustments as prescribed in the AMP. Some of the most significant changes that are needed to make hatchery fry more comparable to natural fry are incorporated in the facility plans that are being developed for the replacement hatchery. These include water temperature control and broodstock collection facilities. Through the existing hatchery we have learned that food supply is not limiting at relatively high sockeye production levels (Beauchamp et al., 2004). We have learned about the effects of release locations of sockeye fry on adult spawner distribution and used this information to guide fry release strategies. We have studied straying and found none in Bear Creek. We have created operating protocols for the broodstock collection weir and documented Chinook spawning distribution to evaluate the effectiveness of the protocols and to adjust them as necessary. We have also learned where there are remaining challenges in evaluating some aspects of the project, including analysis of adult returns and evaluation of the impact of predation on survival in Lake Washington.

While information collected during the operation of the interim hatchery is useful, it is not comparable in every aspect to the planned operation of the replacement hatchery in conjunction with an AMP. Based on research conducted for the AMP, there is a high probability for successfully implementing the AMP. Please refer to General Response No. 2 regarding the use and publication of available data.

TT-57. This SEIS focuses on those issues that the Hearing Examiner directed SPU to address. The issue of river ecology was raised by the commenter at the FEIS appeal hearing and in the post-hearing brief, but SPU did not receive direction from the Hearing Examiner to further examine this question beyond its direct relationship to the issues of genetics, competition, predation, superimposition and competition for spawning sites. Refer also to General Response No. 1.

For discussion of broader issues, please see the HCP Sections 3.2, 4.1.4. Section 4.4. of the HCP EA/EIS discusses potential impacts to the broader Cedar River ecosystem.

TT-58. The goals for the hatchery are presented in Section 1.3 of the SEIS. The hatchery program is intended to increase the production of fry above what the habitat in the lower Cedar River is capable of producing to compensate for not passing sockeye above Landsburg Dam. The additional fry would be expected to result in higher adult returns than would be the case without the hatchery. If adult returns exceed the threshold established by the co-managers, then additional harvest opportunity will result. This may in turn increase sport and/or commercial fishing opportunities. The City does not view the supplementation of fry production and increased sport and/or commercial opportunities as being mutually exclusive.

TT-59. The AMP notes seven objectives in Section 1.1.1, and Section 4 of the AMP establishes a structure that is meant to support and implement each objective.

1) *Address the primary technical uncertainties with respect to performance and effects of the hatchery program*. These uncertainties are noted in the AMP and direct the initial research as outlined in Section 2.
2) *Promote a high standard for scientific work so that results are credible.* See Section 4.4.3, Technical Work Group and Section 4.4.4, Independent Science Advisors.
3) *Effectively communicate scientific results to managers*. See Section 4.4.2, Adaptive Management Work Group.
4) *Provide public access to scientific data*. All data published by SPU are available for public review at SPU's website, or by request.
5) *Provide opportunity for public input to decision-making process.* See Section 4.4.1, Parties to the Landsburg Mitigation Agreement, and Section 4.4.2, Adaptive Management Work Group.
6) *Promote public understanding of decisions*. See Section 4.4.2, Adaptive Management Work Group.
7) *Utilize limited monitoring resources effectively and efficiently*. See Section 4.4.1, Parties to the LMA, and Section 4.4.2, Adaptive Management Work Group.

Refer to General Response No. 5 and Responses 13 and 31 in this letter for discussion of the City's long-term commitment to funding the AMP.

TT-60. The issues raised by this comment are outside of the scope of this SEIS. This SEIS focuses on those issues that the Hearing Examiner directed SPU to address. The

issue of river ecology was raised by the commenter at the FEIS appeal hearing and in the post-hearing brief, but SPU did not receive direction from the Hearing Examiner to further examine this question. Please refer to General Response No. 1.

The replacement hatchery is one component of the Cedar River HCP. The HCP is a multi-species plan that addresses management of river ecology to support a variety of species. The AMP is created to manage the hatchery program in a manner that minimizes impacts to other species in the river, but does not attempt to guide overall habitat programs in the Cedar River. Seattle Public Utilities agrees that habitat change, whether it results from the effects of development, from habitat restoration projects, or from some other cause, should be considered in the evaluation of monitoring results on productivity in the River. Historically, sockeye and Chinook coexisted for many decades and at times coexisted at higher levels than currently exist, suggesting that sockeye and Chinook recovery efforts can both be successful. For further discussion of the overall approach to managing for multiple species in the context of the HCP please see Section 4.3 of the HCP.

TT-61. The cited text is included in the AMP to identify that the entire program has been structured around the concept of developing a program based on sound scientific direction. One specific goal of the AMP is to "Promote a high standard for scientific work so that results are credible." Meeting this stated goal will require the development of sound scientific direction. Seattle Public Utilities is committed to meeting this goal and has structured its current effort around this principle, which will continue as the AMP is finalized. The text of Section 1.1.4 has been clarified.

TT-62. The interim hatchery has not operated under an adaptive management program. The "initial start-up period" referred to relates to the replacement hatchery.

For information about studies conducted during the operation of the interim hatchery please see General Response No. 2 and Response 27 of this letter. See also Appendix C of the FSEIS.

TT-63. From the information available, it is reasonable to assume that hatchery returns to the interim hatchery to date have been less than 50 percent of the sockeye return to the Cedar River. Sampling done in 2004 suggested a range of hatchery returns of about 20 percent (Schroder memo, WDFW, March 2005). Ratios of hatchery to natural origin adults from stream collections between 1997 and 2000 also suggest that hatchery returns were below 50 percent (see Table 10 and 11, Fresh et al., 2003). This experience along with the assessment of the expert scientists who developed the program provides the basis for establishing the 50 percent goal, which will be subject to further evaluation under the AMP. The experts who recommended the 50 percent figure thought that this level would present a low risk of irreversible impact. Many populations have more than 50 percent hatchery origin returns (e.g., many Columbia River stocks where hatchery origin salmon make up 80 to 90 percent of the returns), but this number was chosen as a reasonably conservative level. Results of returns to date will be analyzed by the Technical Work Group prior to establishing an egg take goal under the AMP.

TT-64. As noted in previous responses, the current interim hatchery is not operated under the guidance of an AMP. The operation of the replacement hatchery will be subject to an AMP, and the monitoring and studies will feed directly into the decision-making process as described in Section 4 of the AMP.

Overall responsibility for adaptive management is assigned to the Parties to the LMA (NOAA, USFWS, WDFW and the City of Seattle). In addition, the AMP outlines a detailed process that will be used to implement the proposed AMP program, and Section 4 of the AMP specifically identifies the responsible parties and their range of responsibilities. The various AMP groups will be held accountable by the Parties to the LMA for fulfilling their specific roles in order to provide the needed information to the hatchery managers.

See also General Response No. 2, 4, and 5 and Response 7 of this letter for a discussion of data collected over the past 12 years and how it has been incorporated into the worst case analysis, the AMP, plans for the replacement sockeye hatchery and operating guidelines.

TT-65. Refer to General Response No. 2 and Response 7 of this letter for a discussion of data collected over the past 12 years.

TT-66. This question is discussed in the AMP (see Section 2.1.3 of the AMP). Discussion about the appropriate mix of natural and hatchery production continues, which is why Seattle Public Utilities has identified a level of no more than 50 percent hatchery returns as a starting point for evaluating this question. Refer to Response 63 of this letter.

TT-67. The comment addresses issues that are beyond the scope of this SEIS. The scope of the SEIS was to specifically discuss impacts that the proposed hatchery would have relative to genetics, predation, competition, and superimposition and to further discuss the AMP as directed by the Hearing Examiner. Please see General Response No. 1.

Detailed information regarding the entire Lake Washington sockeye salmon stock is included in the HCP EA/EIS, FEIS, SEIS and other documents.

TT-68. Refer to Response 63 in this letter. As noted in that response, under the proposed structure for the AMP, all questions and assumptions will be subject to ongoing review by the Technical Work Group, the Independent Science Advisers and the interested public.

TT-69. The HCP, one component of which is the replacement hatchery, is funded with revenues from SPU's water utility ratepayers. The funding is not unlimited and the scientific groups described in the AMP will be charged with making recommendations to the Adaptive Management Work Group and the Parties to the LMA about the best use of the available funding. Funding described in the AMP is meant to indicate the likely use of funds in the first 10 years. Funding has been

allocated to continue the AMP for 50 years but has not been dedicated to specific issues because future issues are dependent on the results of current research.

As with all public agencies, funding for work related to the AMP is dependent on the annual budget process of the various agencies participating.

See also General Response No. 5 and Response 13 in this letter.

TT-70. The graphs are presented to establish the point that there is a broad overlap in spawning timing between sockeye and Chinook and therefore that there is potential for interaction between species. Annual variation would not change this point. Actual information on potential interactions resulting from this timing overlap is collected and reported each year by observers in the River and subsequent juvenile trapping.

Your comment has been noted and will be provided to the Technical Work Group for consideration.

TT-71. Section 2 of the AMP identifies "Key Uncertainties" that the science panel felt the AMP should initially address. Section 2 does not address all possible uncertainties. As noted in the introduction to Section 2, "Uncertainties and hypotheses are expected to change over time as questions are answered and new ones emerge."

Uncertainty No. 5 is related to the impacts that hatchery produced fry might have as a result of the time they spend rearing in Lake Washington. Because nearly all hatchery produced and naturally produced fry migrate immediately to Lake Washington after release from the hatchery or emergence from the gravel, the River ecosystem is used very differently than that of the Lake in terms of rearing. The science panel did not feel that the issue of community structure in the River rose to the same level of importance as the other key uncertainties.

The worst case analysis did include evaluation of the risks of predation in the Cedar River (see Appendix B in Part 1 of this FSEIS).

This comment will be provided to the Technical Work Group for their consideration when they meet to review the AMP.

TT-72. Table 3.1 is a summary table. Quantifiable thresholds have been added to the body of the AMP (see various discussions in Section 2 of the AMP).

TT-73. Public and scientific input and review have occurred throughout the HCP and FEIS process. Seattle Public Utilities has involved a team of regionally and nationally recognized experts in its HCP process, FEIS process, SEIS process and in the development of the AMP. The description of the Technical Work Group in Section 4.4.3 allows for the appointment of two additional members to the five specified by discipline. This comment will be provided to the Parties of the LMA for their consideration in making appointments.

It is expected that a variety of research agencies, including university scientists, will be interested in undertaking monitoring and studies related to the AMP. Most, if not all, of the research will be published in peer-reviewed journals. In addition, Section 4.4.4 of the AMP describes the role and selection process associated with the Independent Science Advisors who will provide independent assessments on technical issues.

Providing public access to data, reports and recommendations and providing opportunity for public comment, as discussed in the AMP, is intended to promote public participation and transparency in decision-making.

TT-74. The commenter is referring to Section 4.2 of the AMP, which lists organizations, committees and panels involved in the implementation of the AMP. The Department of Ecology has multiple roles and has been added to Part 1 of this FSEIS.

TT-75. Seattle Public Utilities issued the invitation to serve on the science panel because SPU is the sponsor of the project. Seattle Public Utilities consulted with the Muckleshoot Indian Tribe, WDFW and other agencies prior to issuing invitations. The scientists invited to participate were chosen because of their experience with hatcheries, their expertise in fisheries issues, and/or their familiarity with the Cedar River system or similar systems. The scientists were asked to participate on the panel as objective members. Seattle Public Utilities has continued to seek opposing viewpoints, to fully understand the wide range of concerns associated with hatcheries.

TT-76. Comment noted.

TT-77. Refer to General Response No. 3 for a discussion of the selection of experts from the worst case analysis workshop.

TT-78. Please refer to General Response No. 1. The issues evaluated were those that the Hearing Examiner directed should be addressed in the SEIS. The issues of weir effects and river ecology were not included in the direction of the Hearing Examiner to undertake worst case analysis. Refer to Responses 5 and 60 of this letter.

TT-79. Refer to Response 4 of this letter.

TT-80. Materials were sent to the participating scientists prior to the meeting. Scientists involved in the workshop were invited because they are knowledgeable about the issues and jointly represented decades of evaluating the full range of issues under discussion. The three sessions ran concurrently during the day.

In some cases, the participants were the authors of foundational papers for the topics under discussion. See General Response No. 3 for further discussion of the structure of the worst case analysis workshops and opportunity for review and input.

TT-81. Refer to Response 5 and 60 of this letter and General Response No. 1.

TT-82. The opening paragraph is a summary that explains the issues that the session was asked to discuss and is not in any way conclusionary. The discussion of domestication begins on p. 11 of the summary. On p. 13 the summary states that the group considered the processes by which domestication selection might occur, and "the virtual impossibility of preventing it."

Section 3.2.4.5 of the SEIS, which specifically discussed the conclusions of the analysis related to domestication, states that the "domestication is likely to occur," which is consistent with the workshop summary.

TT-83. The worst case analysis was not based on an actual baseline measure of fitness but rather a theoretical baseline. For the purpose of the worst case analysis, the scientists assumed that there was a natural population structure and they also assumed that this resulted in increased fitness for those individuals. From this theoretical baseline, it was then assumed that the operation of the hatchery would result in homogenization that would reduce fitness. As the commenter indicates, this assumption by the workshop participants was likely to be overly cautious since the actual level of population structure and fitness may be lower than the theoretical baseline. This possibility was considered by the workshop group as described in the "Homogenization of population structure within the Cedar River" section of Appendix B. However, in the end the workshop participants decided that it would be more appropriate for the worst case assessment to focus on the theoretical potential of the population (without hatchery influence) rather than the existing baseline. As a result the issue of potential impacts that may or may not have occurred within the population as a result of the operation of the interim hatchery was not material to the discussion.

See Response 7 of this letter and Appendix C of the FSEIS for further discussion of the results of the interim hatchery and their application to evaluating the effects of the replacement hatchery.

TT-84. The term "fitness profile" is not common in the fisheries literature. Seattle Public Utilities assumes that the commenter means a baseline for those parameters generally associated with reproductive fitness.

The WDFW compiles data on adult spawner numbers and fry output that are available for evaluating productivity of this stock. Continued monitoring will occur periodically to determine if the trends regarding straying appear to change over time. Should negative trends become apparent, additional information may be collected about other sockeye populations, including Bear Creek and/or the beach spawning sockeye populations.

Evidence to date collected over a three-year period indicates that straying rates from the Cedar River sockeye hatchery to Bear Creek are very low (see discussion of straying to Bear Creek in Section 3.2.2 of the SEIS, and FEIS Section 2.4.4). Insufficient data are available to assess productivity of beach spawning sockeye.

TT-85. The discussion of population differentiation in the referenced paragraph is being applied to separate spawning areas (e.g., Bear Creek, Cedar River, Pleasure Point), not to populations within the Cedar River alone. The authors note present differences and suggest that the level of genetic exchange (straying) has been low enough to maintain some distinction between these populations as evidenced by differences in traits.

For the purposes of a worst case analysis for homogenization, the scientists assumed that there is population diversity in the Cedar River. This was a conservative assumption. The scientists did not agree that such diversity exists or does not exist.

TT-86. The discussion of straying to Bear Creek in the workshop summary is contained in p. 3-5. Although the discussion in the workshop summary is rather technical, there is no discussion of homogenization/domestication in the Cedar River in this part of the summary, so SPU is unable to respond to this comment. See Section 3.2.2 in the SEIS for a less technical explanation of straying to Bear Creek.

TT-87. See Response 29 in this letter. The commenter is confusing two separate reports by Fresh. The dates cited for Fresh reports in the SEIS are correct. Fresh et al. (2001) described the results of otolith sampling in Bear Creek in 1998, 1999, and 2000 and is correctly referred to in this workshop summary.

Fresh et al. (2003), an entirely different report, analyzed otolith data collected in the Cedar River from 1995 through 2000 and includes observations about size differentials. This final report by Fresh et al. (2003) was not available prior to the worst case analysis workshop. Size information included in the earlier draft report (Fresh et al., 2002) was included in the FEIS (p.2.4-35) and Appendix A (p.A-8). Several panel members selected for the worst case analysis genetics group were familiar with these results.

TT-88. The worst case assumption for the straying analysis includes up to 50 percent hatchery returns to the Cedar River and an exceedence of the spawner escapement goal by 20 percent (360,000 to the Cedar River). The effects of increased returns are discussed in Section 3.2.2.2 of the SEIS. The analysis in the supplemental evaluation to the workshop summary in Appendix B includes these assumptions as well. Therefore, the analysis does, in fact, include this assessment.

TT-89. The scientists recognized that the Bear Creek population is smaller than the Cedar River population and that stray rates from the Cedar River would be different than the percentage of the Bear Creek population which consisted of strays. Both the straying rate from the Cedar River and to Bear Creek under worst case assumptions are presented in Section 3.2.2.5 of the SEIS. The assessment of impact to fitness and genetic diversity is presented in this section as well. Information regarding the conclusions of the group is included in Appendix B. Refer to Section 1.6.2 of the SEIS and p. 3 of the genetics workshop summary in Appendix B for the methodology used to develop the analysis.

TT-90. The views of these scientists were not discounted or dismissed and have been noted in the workshop summary in Appendix B and in the SEIS itself (see Section 3.2.2.2). The scientists' assumption that no AMP would be in place was included as one of the general assumptions provided to all participants. The opinion that release strategies would change to create additional straying was not widely held in the group. The concerns of these scientists were expressed in the workshop summaries, along with the opinions and concerns of the other participants.

TT-91. The panel did not make a recommendation, but rather agreed that both measures were appropriate for use in the worst case analysis.

TT-92. Discussion of this issue, including specific statements from individual scientists relative to straying and the Lake Washington beach population of sockeye is provided on p. 5-6, genetics workshop summary in Appendix B of the SEIS.

TT-93. See Responses 29 and 87 in this letter. The commenter is confusing two different reports by Fresh et al. The City has not criticized the Fresh et al. (2001) report that analyzes Bear Creek strays.

Seattle Public Utilities agrees that abundance of hatchery returns is expected to increase and it is not clear whether the straying rate will be independent of density or not.

After the workshop, Dr. Quinn evaluated the maximum rate of straying that would be possible given the lack of marked sockeye in samples over three years and found the true straying rate from the Cedar River would have to be low (about 0.2 percent) in order to be undetected, given the number of samples examined by WDFW. (See SEIS Appendix B of the SEIS, supplemental evaluation). This analysis provides further support for the conclusions by the scientists on the genetics panel.

The conclusions in Section 3.2.2.6 of the SEIS apply to the Bear Creek subpopulation; see Section 3.2.2.7 for a discussion of beach spawning subpopulations.

Workshop participants were asked to provide their best judgment regarding what was likely to occur under worst case assumptions, not to specifically apply the precautionary principle. Refer to Response 4 of this letter.

TT-94. All of the assumptions, findings and discussions by the workshop participants are included in Appendix B and are summarized in Chapter 3 of the SEIS.

The straying rate from the Cedar River may or may not change depending on whether straying is density dependent or independent.

Refer to the supplemental evaluation: Estimates of Straying to Bear Creek included in Appendix B for a discussion of how the maximum number of strays was calculated under full production and worst case assumption. Refer to Response 4 of this letter for a discussion of the application of the precautionary principle.

TT-95. Refer to Responses 29 and 87 of this letter.

The commenter is confusing two different reports. The report (Fresh et al. 2001) on straying to Bear Creek was never reviewed by Skalski. He reviewed the draft Fresh et al. report (2002). The work described in Fresh et al. (2001) involved collection of otoliths in multiple samples from Bear Creek for three successive years. Seattle Public Utilities is not aware of concerns over the methodology of the sampling or analysis of this report, and no one raised concerns about this report at the workshop.

TT-96. The Lake Clark and Iliamna Lake system is not comparable with the Cedar River due to differences in the spatial and temporal scales of the systems. The project scientists continue to review published reports, as they become available, including the Ramstad article. The SEIS acknowledges the likelihood of homogenization, outlines the potential range of worst case impacts, and frames the potential mitigation measures. As relevant information becomes available, Seattle Public Utilities will review this information in light of proposed hatchery operations and the proposed AMP, and modify their proposed actions as needed following appropriate scientific and public review.

TT-97. The scientists conducted their assessment by assuming: (1) a distinct population structure either does exist or would develop at some point; and (2) there was some intrinsic increase in fitness as a result of this assumed population structure (see Section 3.2.3.3 of the SEIS). This is conservative or "precautionary" because much uncertainty occurs in this respect and, as the commenter points out, there is no specific evidence that either of these circumstances actually occurs under the existing baseline (the information that was considered is summarized in the homogenization discussion in Appendix B of the SEIS). See also Response 4 of this letter.

TT-98. Comment noted. The summary of the scientists' discussion, the methodology and the assumptions are provided in Appendix B, genetics workshop summary, pp. 11-14 of the SEIS. The assumptions used in the worst case analysis were structured to be inherently conservative. See also Response 4 of this letter.

TT-99. Seattle Public Utilities stands by its process in developing worst case analyses. Refer to General Response No. 3.

TT-100. Refer to Response 4 of this letter.

Each panelist in the predation-competition workshop was asked to assign a probability to the level of change in a response variable. Uncertainty would be expected to generate a wider range of probabilities.

Worst case assumptions were used to ensure that the analysis would be conservative and not underestimate potential effects.

TT-101. The worst case analysis participants discussed this issue, but it was not identified as an issue of significant concern. Assumptions for the analysis did include high fry production every year. Even under these conditions, however, sockeye impact on

food supply would be expected to be minimal. Food limiting circumstances would also be reflected in records of zooplankton samples (Mills and Schiavone, 1982); this has not been the case. Refer to Appendix B, p. 17 of the SEIS, for additional information on studies by Dave Beauchamp that were used to make this determination in the worst case analysis workshop.

Size-selective mortality could very well be operating on juvenile salmon; however, the conclusion that food is not limiting was arrived at independently by comparing the total monthly consumption demand by all planktivorous fishes plus *Neomysis* to the supply of exploitable zooplankton. During the growing season of mid-April through November, the combined consumption by all planktivores represented a small fraction of the exploitable zooplankton biomass and production (Beauchamp 1996). During the potentially most food-limited period (March-early April), sockeye fry and presmolts were the major zooplankton consumers during winter-spring, but still would consume less than 25 percent of the available zooplankton biomass under the projected sockeye hatchery scenarios.

A number of scientific papers document the effect of limited food supply on sockeye or kokanee in lakes as reducing smolt size. See:

Beauchamp, D. A., C.J. Sergeant, M. M. Mazur, J. M. Scheuerell, D.E. Schindler, M.D. Scheuerell, K.L. Fresh, D.E. Seiler, and T.P. Quinn. 2004. Temporal-spatial dynamics of early feeding demand and food supply of sockeye salmon fry in Lake Washington. *Transactions of the American Fisheries Society* 133:1014-1032.

Hyatt, K.D., and J.G. Stockner. 1985. Responses of sockeye salmon (*Oncorhynchus nerka*) to fertilization of British Columbia coastal lakes. *Canadian Journal of Fisheries and Aquatic Sciences* 42:320-331.

Mazumder, A., and J.A. Edmundson. 2002. Impact of fertilization and stocking on trophic interactions and growth of sockeye salmon. *Canadian Journal of Fisheries and Aquatic Sciences* 59:1361-1373.

Mills, E.L., and A. Schiavone. 1982. Evaluation of fish communities through assessment of zooplankton populations and measures of lake productivity. *North American Journal of Fisheries Management* 2:14-27.

Rieman, B.E., and D.L. Myers. 1992. Influence of fish density and relative productivity on growth of kokanee in ten oligotrophic lakes and reservoirs in Idaho. *Transactions of the American Fisheries Society* 121:178-191.

TT-102. Refer to General Response No. 3.

TT-103. This evaluation relied upon the experience, expertise and judgment of the workshop panelists, all of whom have knowledge of the issue and who had relevant experience in the Cedar River system or elsewhere. Following completion of the workshop, the summary was provided to panelists for review and the opportunity to suggest changes, which were incorporated into the summary.

TT-104. The commenter has identified a typographical error in the text that has been revised in the FSEIS. The interim sockeye hatchery has been operated on a seasonal basis since 1991 and the first year of releases was in 1992, as the commenter states. Since the interim hatchery began operations, fry, not smolts, have been released.

TT-105. The assumptions on p. 3 of the Spawning Ground Competition and Chinook Salmon Redd Superimposition by Sockeye Salmon in the Cedar River Worst Case Scenario Report were based on best professional judgment of the participants, referencing available data and studies. Dominance as used in this case refers to the ability of Chinook to defend their nests against intrusion by other salmon. There was a consensus among workshop participants on this issue. Seattle Public Utilities is unable to find instances where the document suggests that "sockeye don't dig up their [Chinook] redds" as suggested by the commenter. Instead, the analysis states that, while superimposition clearly occurs, the impact of that superimposition is likely to be minor for various reasons discussed in the summary.

TT-106. The basic assumption outlined by the commenter is not found in the basic assumptions on p. 3 of the spawning ground competition summary in Appendix B of the SEIS. Assumption (b) states, "Chinook may move to areas where sockeye are not present, but their secondary site is no less effective than the primary site." This finding of the scientists is based on several factors, including the low density of Chinook in the Cedar River relative to the potential spawning habitat available, the inherent selection for salmon to make good choices in redd site selection, and the wider range of spawning conditions available to Chinook to spawn in deeper, higher velocity parts of the River (see Assumption [c]). Available data from the Cedar River do not support the concern that Chinook are forced to alternate areas where survival would be adversely impacted.

There has been no specific study comparing habitats as suggested by the commenter. The comparison of the habitat on the scale requested is difficult, if not impossible, to measure throughout the River. It is undoubtedly subject to variation in time and space, and by individual, and will vary from year to year as flow and other conditions vary.

Continued collection of Chinook and sockeye spawner numbers, redd overlap, and juvenile Chinook production is planned to identify whether sockeye abundance or superimposition rates are inversely correlated with juvenile Chinook production, taking into account other environmental variables.

TT-107. This language reflects the professional judgment of the panelists, all of whom brought years of experience working in the Cedar River system to the workshop. Part of the reason that this worst case analysis was required was that there is uncertainty about this issue, i.e., no definitive studies have yet been done. Therefore, SPU relied on the best professional judgment of experts in the subject area to suggest the likely outcome of a worst case scenario.

This is further supported by observations contained in the Burton et al. (2004) report that indicated that Chinook may select spawning areas away from spawning sockeye. If energy expenditures significantly changed and resulted in a significant reduction in the time that the female can protect her nest, this might be expected to reduce egg to fry survival. Available data do not indicate that higher sockeye numbers result in lower Chinook survival.

TT-108. Please see Burton et al. (2001, 2002 and 2003) as referenced in the SEIS for listing of studies about the depth and velocity of habitat utilized for Chinook redds. There have been no studies specific to the Cedar River to empirically determine the validity of the observations of the workshop participants, who were asked to use their best professional judgment about an issue that was deemed to be sufficiently uncertain as to require a worst case analysis for the purposes of SEPA. Available data do not indicate that higher sockeye numbers result in lower Chinook survival.

TT-109. The worst case evaluation included conservative assumptions intended to identify worst case outcomes. Professional judgment was used to predict effects and their probability. The conclusions were not, as the commenter suggests, that under a worst case analysis there would be, "no effect on Chinook spawning success." Please see Section 3.6.2.5 of the SEIS for the actual conclusion stated. Continued monitoring under the AMP, even in the face of the prediction of minor impact, represents a cautious approach to the uncertainties of this issue. See further discussion in Response 4 of this letter.

TT-110. The group acknowledged that there is overlap in the habitat used for spawning by Chinook and sockeye and that superimposition does occur. They further acknowledged that on average, Chinook spawning habitat was often different from average sockeye habitat based on water depth and velocity and gravel size. Please see p. 3 of the workshop summary for competition for redd sites which states: "Chinook appear to select different sites when sockeye are more numerous than in years when sockeye are less abundant, and therefore Chinook may be avoiding the annoyance of a large number of sockeye by *moving to sites sockeye are not able to occupy*."(emphasis added)

TT-111. The issue of superimposition is discussed in the worst case analysis and included in the AMP because there are uncertainties about our understanding of these issues. Although other variables could, and may, have played a role, the scientists were asked to provide their best professional judgment on the issues presented. They note that existing data support, rather than undermine, that best professional judgment.

TT-112. Comment noted.

From: "Heather Trim" <htrim@pugetsound.org>
To: <vikki.anselmo@seattle.gov>
Date: 3/21/2005 3:12:13 PM
Subject: Official Comments to the Cedar River Sockeye SEIS

Hi Vikki,

Please see our attached comment letter. A hard copy will follow by mail.

Thanks,
Heather

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March 21, 2005

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Vikki Anselmo
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700 5th Avenue, Suite 4900
P.O. Box 34018
Seattle, WA 98124-4018
vikki.anselmo@seattle.gov

RE: Cedar River Sockeye Hatchery Project Draft Supplemental Environmental Impact Statement (SEIS)

Dear Mr. Clarke and Ms. Anselmo,

Thank you for the opportunity to review and comment on the *Cedar River Sockeye Hatchery Project Draft Supplemental Environmental Impact Statement* dated February 2005.

1 People for Puget Sound is a nonprofit, citizens' organization whose mission is to protect and restore Puget Sound and the Northwest Straits, including a specific goal to protect and restore the 2,000 miles of Puget Sound shoreline by 2015. We focus on water quality and habitat, advocating that the State of Washington and its counties and cities devote more resources to the prevention of further degradation of the Sound.

2 We share the city's overall goal to restore and improve the salmon runs in Puget Sound; we are concerned, however, about the advisability of building a hatchery in the Puget Sound basin at this time. There is significant controversy about the siting and operation of our existing hatcheries. Scientists have not agreed that hatcheries are desirable facilities – that they might be contributing to the loss of some salmon runs or that major operational changes are needed. Why build a new hatchery now in this uncertain environment?

Our additional concerns about the project include:

3 • **Negative impact on wetlands.** Existing wetlands in the immediate area must be preserved and enhanced. Puget Sound has lost over 90% of our marine wetlands and an unknown percentage of our freshwater wetlands. Wetlands provide critical nursery habitat as well as significant additional benefits

4 • **Negative impact on Chinook recovery efforts in WRIA 8.** The planning for WRIA 8 salmon recovery should be closely tied with this proposed hatchery project. Is this project approved by WRIA 8 as a project that will benefit Chinook?

• **N**

5 **egative water quality impacts**. Wastewater from fisheries, even with effluent limitations, can be a significant contributor of contaminants to a water body.

6 We urge the City of Seattle to address these issues and to work closely with WRIA 8 and NOAA/NMFS to ensure that no action is taken that will negatively impact our listed Chinook.

If you have any questions, please feel free to call me at (206) 382-7007 X215.

Sincerely,

Heather Trim,
Urban Bays Project Coordinator

Responses to Comment Letter PE (People for Puget Sound)

PE-1. Comment noted.

PE-2. This comment addresses the question of whether or not the construction of the hatchery is a wise public policy decision. While that is an appropriate question for decision-makers, it is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Refer to General Response No. 1 for a discussion of the scope of the SEIS.

PE-3. Comment noted. Wetland impacts were discussed in Section 2.5.3 of the FEIS and are outside the scope of this SEIS. Refer to General Response No. 1 for a discussion of the scope of the SEIS.

PE-4. The WRIA 8 Plan has not yet been approved by NOAA Fisheries. The SEIS discusses the potential impacts of the proposed additional hatchery production on Chinook in Sections 3.3, 3.4, 3.5 and 3.6. Refer to General Response No. 6 for a discussion of the SEIS and the proposed project in relation to the WRIA 8 Plan.

PE-5. Comment noted. Water quality impacts were discussed in Section 2.3.3 of the FEIS and are beyond the scope of this SEIS. Refer to General Response No. 1 for a discussion of the scope of the SEIS.

PE-6. Comment noted. The City of Seattle is an active partner in WRIA 8 and will closely follow developments in that venue. NOAA Fisheries is a Party to the LMA and is part of the decision-making body for the AMP, along with USFWS, WDFW, and the City of Seattle. In addition, NOAA Fisheries has evaluated the hatchery; see General Response No. 6.

From: "Charles Raines" <ccraines@comcast.net>
To: <vikki.anselmo@seattle.gov>
Date: 3/21/2005 10:54:25 AM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

Ms. Anslemo,

Attached are the comments of the Sierra Club on the SEIS for the proposed Cedar River Sockeye Hatchery. We will also send you a printed copy, shortly.

Charlie Raines

Director

Cascade Checkerboard Project

Cascade Chapter

Sierra Club

SIERRA CLUB
Cascade Chapter
180 Nickerson #200
Seattle, Washington 98109

March 21, 2005

Vikki Anselmo
Seattle Public Utilities
700 - 5th Avenue, Suite 4900
PO Box 34018
Seattle, WA 98124-4018

Re: Cedar River Hatchery DSEIS

Dear Ms. Anselmo,

1 The Sierra Club is submitting these comments on the Draft Supplmental EIS reqarding the proposed Cedar River Sockeye Fish Hatchery. We are now revisiting an issue on which we commented during the devleopment of the HCP. The issues have changed little, the proposal has changed little, the impacts are still there, and our position is still that the hatchery should not be built.

In those earlier comments, we questioned the validity of a wild stock of sockeye in the municipal watershed. We raised concerns over the impacts to native species, especially chinook salmon. This included food and predation in Lake Washington, impacts to chinnook redds by sockeye, and hatchery stock interbreeding with other sockeye in the Lake Washington system. We suggested that funding could better be spent on habitat acquisition and restoration. We also argued for an adaptive managment program that truly meets the definiton. We had suggested that production at the existing or new hatchery be kept at low levels until data was developed on the effects- including those mentioned above. Only if there were positive (not uncertain) results from monitoring should production be increased; and then only in small increments. If monitoring results were neutral, production could continue, but if results were negative then production should be reduced immediately.

Since those comments in 1998, additional information has been gathered and planning for the Cedar River watershed has progressed. These reinforce our earlier concerns.

2 Issues
The WRIA 8 plan for Chinook salmon recovery was released prior to this SEIS, so it was not able to assess the hatchery's impacts. However, NOAA's Puget Sound Chinook Technical Review Team (TRT), has identified the hatchery as a major uncertainty in the WRIA 8 recovery plan. The TRT has concluded that none of the 22 extant Chinook populations in Puget Sound are expendable, and that the Cedar River is in the highest tier of concern and need for recovery amongst all Puget Sound stocks.

2 The SEIS does not provide an adequate analysis of the hatchery's impact on Chinook salmon recovery and it ignores or dismisses recent data that documents the negative effects of the weir on chinook migration and distribution. These are major flaws of the document.

3 Furthermore, reviews conducted by two separate NOAA ESA science advisory panels have recently concluded that hatcheries carry high risks of negative effects. Their findings add to the already extensive body of literature about hatchery problems. The City of Seattle downplays or ignores these risks.

4 The City's own studies show that hatchery fish are not comparable to wild stocks. The SEIS acknowledges that it is virtually impossible to prevent the genes of wild sockeye from mixing with those of hatchery sockeye. This results in reduced fitness of wild fish. This likely impact is a direct violation of state law that requires artificially produced fry to be comparable to wild fish.

5 There is still no summary of over ten years of study on the current temporary hatchery and its impact on wild fish, and lake and river conditions. Other studies (e.g., Fresh, 2003) have found effects, such as hatchery fish returning smaller than wild fish. The temporary hatchery was continued under the original Adaptive Management experiment. But without that rigorous review, the information to support continued operations is lacking.

6 If the hatchery becomes fully operational (producing 34 million sockeye fry annually), and habitat improvements increase Chinook populations, will there be enough food in Lake Washington to sustain both populations?

7 Will increased sockeye numbers cause them to spawn on top of Chinook redds, and will Chinook be forced to spawn in undesirable sites subject to high flows or scour which could lower their reproductive success?

8 The "worst case scenario" examined in the SEIS failed to adquately consider the potential impact on Chinook recovery.

9 The hatchery's recommended budget is for approximately 10 years of operations, including study of potential impacts, yet it is expected to operate for at least 50 years. The HCP anticipated budgets for other management for 50 years. Why not here? No funding is identified for fixing any negative impacts on Chinook or other salmon runs that might occur. It is not clear where these funds will come from and there is a concern that these costs may negatively impact habitat-based mitigation funding for Chinook recovery.

10 <u>Recommendation</u>
The SEIS is inadequate to support a decision to proceed with construction of the proposed hatchery. Thus, we recommend that the City of Seattle not pursue building a sockeye salmon hatchery. In keeping with emergent WRIA 8 policy, funding should be dedicated to habitat-based projects that will benefit multiple species of salmonids and other fish, especially ESA listed Chinook salmon, rather than into a hatchery designed to benefit a non-native stock of sockeye salmon. Such habitat-based measures means protection and restoration of floodplains, estuaries, riparian corridors and upland forests, rather than simple construction of side channels, additions of LWD, and stormwater treatments, which address only a single-species or a single

10 aspect of an ecological process (e.g., peak storm flows but not stormflow duration).

11 Only after a rigorous analysis of effects on wild stocks and clear delineation of potential impacts and development of effective mitigation measures should a hatchery be reconsidered. And then, long term funding and montioring and adaptive managment as noted above would be necessary.

Thank you for this opportunity to comment.

Sincerely,

/s/
Charles C. Raines
Director
Cascade Checkerboard Project

Responses to Comment Letter SC (Sierra Club)

SC-1. Comment noted.

SC-2. Please see General Response No. 6 for a discussion of the WRIA 8 plan and evaluations of impacts of the hatchery on Chinook.

Refer to Letter TT, Responses 21 and 22 for a discussion of the conclusions of the TRT and the status of Puget Sound Chinook populations. Refer to Letter TT, Response 25 for a discussion of weir impacts on Chinook.

SC-3. Refer to Letter TT, Response 23 for a discussion of these two reviews.

SC-4. The commenter makes a legal argument that is outside the scope of this SEIS as established by the Hearing Examiner: to conduct worst case analyses on specified topics and to further discuss the Adaptive Management Plan. Please see General Response No. 1.

SC-5. Refer to General Response No. 2 for a discussion of the availability and use of data, and to Letter TT, Response 29 for a discussion of the 2003 Fresh report. Refer to Letter TT, Response 56 for a discussion of the operation of the interim hatchery and its relationship to the proposed AMP.

SC-6. Refer to Letter TT, Response 30 for a discussion of food supplies in Lake Washington, and to the discussion of food supply in Appendix B of the SEIS.

SC-7. Refer to Letter TT, Response 30 for a discussion of impacts to Chinook spawning, and to the discussion of spawning site competition and superimposition in Appendix B of the SEIS.

SC-8. Refer to Letter TT, Response 30 for a discussion of impacts to Chinook recovery. Refer also to General Reference No. 6.

SC-9. Refer to General Response No. 5 for a discussion of funding for the AMP. Refer also to Letter TT, Response 31.

SC-10. Refer to General Response No. 1. The SEIS addresses the issues raised by the Hearing Examiner. The decision by the city on the allocation of funding addresses the policy question of whether or not the construction of the hatchery is a wise public policy decision. While that is an appropriate question to be addressed by decision-makers, it is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner.

SC-11. Please refer to General Reference No. 1. Impacts and mitigation measures have been discussed in the SEIS to addresses the issues raised by the Hearing Examiner. The decision by the city on the allocation of funding addresses the policy question of whether or not the construction of the hatchery is a wise public policy decision. While that is an appropriate question to be addressed by decision-makers, it is not

directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Refer to General Response No. 5 for a discussion of funding.

From: "Frank Urabeck" <urabeck@comcast.net>
To: "Vikki Anselmo" <Vikki.Anselmo@seattle.gov>
Date: 3/21/2005 3:55:17 PM
Subject: Offical comment to the Cedar River Sockeye Hatcherr DSEIS

Ms. Anselmo:

Please consider the following comments as complementing my testimony given at the March 10 Hearing in Renton, Washington. Both are the official views of the Washington Council of Trout Unlimited on the subject DSEIS:

1 1.. The document is well written and appears to be very responsive to the Seattle Hearing Examiner's directive to address issues that involve uncertainty. The experts workshop process used by SPU to produce the DEIS is very sound. It was an open process with stakeholder representatives allowed to observe, including individuals who are opposed to the hatchery or some aspect of the proposed operation..

2 2.. Science reflected in the document is current and best available. As a member of the monthly meeting SPU Anadromous Fish Committee with an engineering background and extensive technical involvement with fish enhancement programs, I have tracked the studies, data and analysis used to plan and design the hatchery and its operating program. This work is very impressive and reflects well on Seattle and the other entities that have been involved, including the Washington Department of Fish and Wildlife, U.S. Fish and Wildlife Service, NOAA-F and the Muckleshoot Indian Tribes. What is clear is that if the hatchery goes forward there will be additional science employed in the operation and monitoring of the facility as part of the Adaptive Management Plan. Seattle Public Utilities has been aggressive in pursuing use of science and sought the input and advice of eminent scientists and other experts. No other proposed fish production project has received so much evaluation. It has benefited from the 14 years operation of the temporary existing hatchery and the lower river sockeye fry counting trap -- providing incredable amount of data useful for trend analysis and adjustments in operating procedures. The temporay hatchery has been closely monitored by NOAA-F to ensure compliance with the national Endangered Species Act.

3 3.. If the proposed hatchery is blocked by opponents, there is no alternative that can achieve the same objectives and comply with the 1989 State legislation. Furthermore, the expectation is that no further studies of Lake Washington basin sockeye would occur as there would be no other funding source for this work. Without hatchery supplementation there would be insufficient returning sockeye to support tribal and sports fisheries, resulting in tremendous foregone opportunity for significant economic and social benefits, as well as a loss of what has been a major quality of life aspect of the region.

4 4.. Pg. 1-13/1-14, 1.6.2.1 Worst Case Assumptions In the FSEIS some of the quantifiable assumptions should be clarified to help the reader understand if these extreme conditions are premised for every year of operation or just on the average. If the former, then the assumptions are too extreme and produce an unreasonable "Worst Case." Particularly bothersome is the assumption that the escapement goal would be exceeded by 20% each year resulting in a Cedar River spawner count of 360,000. A review of spawner escapement since 1982 reveals that only in one year -- 1988 -- was this magnitude even approached. That fishery lasted more than 30 days, using fishing gear and techniques that have since be superceded. With the current harvest management and tribal and sport fishing power, allowable harvest was achieved in 2002 and 2004 with only three days of effort. Even with a doubling of the hatchery production capacity, harvest management is capable of keeping spawner escapement at 200,000 or less, which has been the case over the past decade.

5 5.. It was interesting that, even under Worst Case Assumptions, that the experts concluded the proposed hatchery would not have significant adverse impacts on the ecosystem, including natural production sockeye and other salmon species such as Chinook. There might even be some benefits for Chinook.

6 6.. Pg 2-1, The Adaptive Management Plan The AMP presents a sound approach to addressing the uncertainties of the project. Scientists and other experts employed in producing the updated AMP are well-recognized -- leading to public confidence. Many of these individuals are expected to continue their involvement as part of long-term research associated with hatchery production and implementation of the Cedar River Habitat Conservation Plan. While not likely to be necessary, the AMP provides for the closure of hatchery operations if unanticipated problems arise that can not be ameliorated by adjusting the operations of the hatchery. This is a very unusual project provision and concession by Seattle. The

6 Washington Council of Trout Unlimited has a keen interest in making sure that the project performs as intended and therefore expects to continue in an oversight role during the implementation of the AMP. WCTU serves on the Anadromous Fish Committee and the Habitat Conservation Plan Oversight Committee. Some of us have been professionally involved with Lake Washington sockeye enhancement for more than thirty years.

7 7.. The public, including a King County Councilman, Reagan Dunn, was unanimous in expressing support for the hatchery at the March 10 public meeting. At the same time the public also expressed extreme frustration over the construction delays and asked that both Seattle and King County officials be held accountable for those delays. It is time to move forward with the permanent hatchery on the basis of the DEIS.

Frank Urabeck
Washington Council of Trout Unlimited
253-826-0282

CC: "Terry Turner" <tnturner@comcast.net>, "Ric Abbett" <troutunlimited@localaccess.com>, "Bart Madison" <Bmadison01@aol.com>

From: "Mark Taylor" <emtbckt@msn.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/6/2005 7:43:17 AM

8 Dear Ms. Anselmo and Other Concerned Parties, I am writing on behalf of the 5500 members of the largest salmonid conservation organization in Washington State, The Washington Council of Trout Unlimited to support the Cedar River Sockeye Hatchery. I am well aware of the extensive data gathering and research that has been used to design the new hatchery and the many scientists that have been consulted to ensure that the facility meets expectations without significant adverse impacts. The Draft SEIS for the Cedar River Sockeye Hatchery Project is well-written and appears fully responsive to the requirements of the Seattle Hearing Examiner. The proposed permanent hatchery will clearly be a state of the art facility, providing a model for any othe future hatcheries. As currently designed, the facility, along with its impressive adaptive management plan, meets and surpasses all questions regarding environmental impact and recovery of endangered salmon. The increased sockeye returns will produce

9 many more opportunities for area recreational fishermen & tribal commercial fisheries. These opportunities will also result in increased revenue for local and state economies due to increased license sales, boat launch fees, tackle, fuel and sundries sales and their included sales taxes. The extra fish

10 returning to the hatchery will also lead to an increase in nutrients being introduced into the system which will provide more food for young ESA listed Chinook salmon and steelhead. These increases will benefit everyone with a win/win for both people and fish. As any resident of the Pacific Northwest knows, salmon are a critical part of our heritage. Increasing and restoring this highly visible urban salmon run will help to keep salmon recovery in the eye of the public and make sure that this symbol of our heritage will not

11 become another casualty of progress. I thank you for this opportunity to speak on behalf of the fish and the fishing community. Mark Taylor Vice President- Membership Washington Council of Trout Unlimited Member- International Game Fish Association, Lake Chelan Sportsman's Association. North American Fishing Club, Recreational Fishing Alliance, Registered Voter

Thank You, Mark Taylor
WCTU Membership VP

Responses to Comment Letter TU- Washington Council of Trout Unlimited

Frank Urabeck

TU-1. Comment noted.

TU-2. Comment noted.

TU-3. Comment noted.

TU-4. Comment noted. The assumption that the escapement goal would be exceeded by 20 percent was suggested in the SEIS to provide a worst case situation. This reflects the possibility of exceeding the current escapement goal of 300,000 in the Cedar River by underharvesting the return. While it is acknowledged that such a scenario may overstate likely adverse impacts, such an approach was used to provide decision-makers with a conservative worst case scenario on which to base their decisions. This approach is consistent with SEPA rules for developing worst case evaluations, and it effectively responds to the Hearing Examiner's decision.

TU-5. Comment noted. Chapter 3 of the SEIS provides a summary of the results of the worst case analysis workshop.

TU-6. Comment noted.

TU-7. Comment noted.

Mark Taylor

TU-8. Comment noted.

TU-9. Comment noted. Impacts to recreational fishing were discussed in Section 2.7 of the Final EIS. While the SEPA rules do not require the discussion of economic impacts in an EIS, your comments will be available to decision-makers as part of the record.

TU-10. Comment noted. Section 2.4 of the Final EIS discusses food availability for young salmonids.

TU-11. Comment noted.

From: "Bill Robinson" <fishadvocate@earthlink.net>
To: "Vikki Anselmo" <Vikki.Anselmo@seattle.gov>
Date: 3/21/2005 9:43:44 PM
Subject: March 21.doc

Official Comment to the Cedar River Sockeye Hatchery SEIS.

March 21, 2005

Vikki Anselmo
Seattle Public Utilities
700 5th Ave. Ste. 4900
POB 34018
Seattle, WA 98124-4018

Re:Official comments to the Cedar River Sockeye Hatchery DSEIS.

Ms. Anselmo:

1 I would like to congratulate Seattle Pubic Utilities for the high quality Draft Supplemental Environmental Impact Statement which has been produced for the Cedar River Sockeye Hatchery.

Overview of Comments:

2 The DEIS has been prepared in response to the Seattle Hearing Examiner's concerns (resulting from a legal challenge to the FEIS) relative to two areas of concern in the FEIS. These two areas are the "Worst Case Scenario" and the "Adaptive Management Plan". One of the goals of this project was to develop an SEIS which was fairly easy to understand. This has been accomplished. However, the "Worst Case Scenario" has been much less easy to understand and is quite frankly much more of a "nebulous" concept.

3 SPU has once again brought together many of the top fisheries science experts from a variety of agencies and institutions with expertise in sockeye salmon biology, Lk. Washington ecology, fish diseases, genetics and recent hatchery reform initiatives, to review to a higher level of specificity, the components of what would cause or otherwise contribute to a "Worst Case Scenario". Several of these scientific experts were involved as the scientific panel in 2000 to advise the City and other signatories to the Landsburg Mitigation Agreement in developing and implementing an effective, comprehensive and biologically sound artificial production program consistent with the SPU Habitat Conservation Plan.

On April 29, 2004, SPU brought 15 regional and nationally recognized salmon experts together for a one day workshop to help identify what components of a "Worst Case Scenario" would include, how would impacts resulting from this "standard" be recognized, how would these changes be quantified (i.e. a set percentage or a range of percentages) and more importantly dealt with.

3 I was fortunate to have been invited to observe the process and deliberations of these experts.

4 The groups of scientists exchanged ideas in "give and take" situations. They were respectful of each others opinions and in several cases, opinions of the experts were modified or changed as a result of the dialogue. An example of this would be the issue of Cedar River produced sockeye "straying" into the Bear Creek system. There were several varying opinions of this issue revolving are a "range" of impacts to the Bear Creek ecosystem. In the end,

the group arrived at the conclusion that the impacts to Bear Creek sockeye by Cedar River sockeye would be low. However, there was a limited concern by some of the group that there might be potential impact beyond the 50 year life of the HCP. This is an uncertainty which should be an issue for the Adaptive Management Work Group and associated Work Groups.

5 The end result of the "Worst Case Scenario", in my opinion, is that it validates the original findings in the FEIS. The conclusion is that the Cedar River Sockeye Hatchery poses a low level of negative impacts to ESA listed chinook salmon in the Cedar River and Lake Washington or other fish species in the ecosystem.

6 The DEIS also includes a revised Adaptive Management Plan. It is a critical component of the HCP. The review of all of the components of the HCP are necessary for an accurate and evolving evaluation as to whether or not the goals of the HCP are being addressed. The DEIS deals specifically with the Landsburg Mitigation Agreement and focuses on the proposed sockeye hatchery fish and flows. The Bear Creek deliberations by the panel of experts identifies an uncertainty which should be addressed via the AMP process.

7 It is somewhat ironic that several of the critical uncertainties relative to the Genetic and Fitness component of the DEIS are not addressable under the current use of the "Interim Hatchery" (built in 1991 a "Temporary" facility) due in large part to the lack of control over water temperatures, water quality certainty, incubation density, timing of release, threats of water borne pathogens to the incubation process and other issues. The current hatchery facility is basically unable to address these critical uncertainties due to its current design and size.

Specific Comments: The Cedar River Hatchery

8 This proposed sockeye hatchery is an integrated mitigation hatchery which has an "expected goal of augmenting the natural sockeye spawning

8 in the Cedar River and to produce a greater more consistent number of returning adult sockeye than would return without it". The hatchery is a supplementation program as identified by the scientific advisory panel with a goal of producing up to 34 million fry. "The objective of the proposed Cedar River Sockeye Hatchery project is to implement a biologically and environmentally sound sockeye salmon hatchery program"(DEIS). The proposed facility has been lauded by the conservation group, Trout Unlimited and their Washington Council. Trout Unlimited National has identified the proposed hatchery as a example of how a modern "landscape" hatchery facility should be designed and operated for the project objectives which were identified in the original FEIS. There are two areas which TU has concerns, the sockeye are not an indigenous specie and that there is little genetic work done to maximizing breeding diversity. The latter issue should be a topic for the AMP decision making process.

9 The Hatchery Science Reform Group has reviewed the project objectives and concluded that "A fundamental goal of an integrated program is for the hatchery broodstock to be as similar genetically as possible to naturally spawning populations, in areas where fish are released and/or collected for broodstock. The long term goal is to maintain the genetic characteristics of a local, natural population among hatchery origin fish by minimizing genetic changes resulting from artificial production and potential domestication. In an idealized integrated program, natural-origin and hatchery-origin fish are genetically equal components of a common gene pool." "One goal of integrated hatchery programs is to minimize the genetic effects of domestication by allowing selection pressures in the natural environment to drive the genetic constitution and mean fitness in the population as a whole."

There is little question that the proposed sockeye hatchery has been identified as an excellent example of how hatcheries should be designed and operated by both Trout Unlimited and the HSRG. "The program should avoid or minimize detrimental impacts on the reproductive fitness and genetic diversity of naturally reproducing sockeye salmon populations in the Cedar River and Bear Creek basins." This issue has been examined by the scientific advisors and found to be a low probability based upon current scientific data and understanding.

Specific Comments: Genetic Impacts under the "Worst Case Scenario"

The DEIS identifies Straying, Homogenization and Domestication as areas of concern under the "Worst Case Scenario". However the DEIS also recognizes that these issues are also present in the natural setting of salmon ecology.

10 "Straying" is a component of salmon ecology as they seek out new habitats to colonize. However, it is recognized that "straying" of sockeye "may still be evolving toward a suite of locally adapted traits". However, in studies done in Bear Creek, in 1998, 1999 and 2000, examining 1,219 otiliths from sockeye, there was not one otilith which could be identified as a product of the "Interim" hatchery from the Cedar River. The "Worst Case Scenario" for straying of Cedar River

10 hatchery sockeye into the Bear Creek system is less that 1%. The impacts to the genetic diversity and fitness is very minimal.

11 "Straying" in the "Beaches Population" may have a higher level of interaction between Beach Populations and Cedar River migrants. However, that level is affected due in large part to the close distance between "Beach Populations" and the Cedar River. However, these "Beach Populations" have not have a lot of scientific scrutiny due to their small populations. Also, it appears that these populations appear on their spawning grounds in mid to late November which is long after the peak migration of sockeye into the Cedar River. However, due to the small populations, these stocks may face diminished genetic diversity and fitness as a result of geographic locations.

12 It is important to note however, that (Spies 2000) concluded that all sockeye populations in the Lake Washington Basin are likely derived from Baker Lake stock. This issue is an uncertainty which should be addressed for further investigation and action by the AMP.

13 ""Homogenization" occurs when individuals from one or more subpopulations or reproductively isolated group interbreed with other groups to the extent that adaptive traits of the previously isolated groups are compromised.". In the Cedar River, it is assumed that there is to some degree natural homogenization. However, the understanding is that hatchery will be "managed to maximize the mixing of hatchery-produced and naturally-produced fish each year to the extent possible through the design of the broodstock collection program. The fundamental goal of the proposed hatchery program is to produce an integrated run in the Cedar River. It should be recognized that the building of the new weir in the very lower reaches of the Cedar River near the I-405 Bridge site will help to develop and integrated run in the Cedar by providing a significant diverse collection of sockeye from across the area under the curve. This action will bring in additional diversity traits in to the broodstock population while also getting additional and more accurate estimates of run return populations and diverse locations of spawning activities. Again, it most be recognized that the impact to fitness of the population as a whole (within the Cedar River) would be very low because the level of genetic differentiation is low. Also, all populations in the Lake Washington basin have their origins from Baker Lake plantings in the 1990's. The Worst Case Scenario the chance of less than a 10% reduction in fitness is 65%. This is within the boundaries of acceptability in the Cedar River basin. In an integrated hatchery, this impact will be minimized due to hatchery operations.

14 ""Domestication" occurs when hatchery operations or management decisions result in the production of fish that have traits that make them more adapted to the hatchery environment but less adapted to the natural environment." It is the objective of the proposed project to implement a biologically and environmentally sound sockeye hatchery program. The management objectives will attempt to minimize the impact of the hatchery operations on domestication. However, it is a recognized fact that domestication occurs wherever there are hatchery influences. Under the Worst Case Scenario the reduction in fitness closely parallel that of homogenization. In an integrated hatchery, this impact will be minimized due to hatchery operations and broodstock collection strategies. The long term goal is that no more than 50%, calculated on a

14 long term average, of the adult sockeye returning to the Cedar River would be of hatchery origin. In addition, the rearing and feeding of fry at the hatchery would be limited to no longer than two weeks. There is much complexity of this issue (and section for that matter). The difficult nature of quantifying adults and fry would be combined with he high levels of natural variation and current uncertainty regarding the relationships between density, flows and fry production. These factors would probably make it difficult to detect any but the most dramatic reductions in fitness. It is unknown how long it takes for genetic changes to affect fitness. This issue and section for that matter, must be investigated and studied by the AMP.

15 "Monitoring and Adaptive Management" of genetic impacts are an important uncertainty. The DEIS does a good job of identifying actions which will help to monitor the impacts of straying, homogenization and domestication. The listed criteria to be monitored is a good starting point. Over time, as the issues are addressed by the AMP, a better set of questions to be asked or the criteria to be monitored may well be necessary. It is important to recognize that the current "Interim" hatchery does a poor job in regards fry migration timing or divergence. The current facility, with a poor source of water, uncertain water quality, temperature control and potential pathogens from spawning sockeye near by is a facility poorly suited to consistency. The new facility will be much better suited to address the short falls of the current facility.

16 Specific Comments:Predation under the Worst Case Scenario
"The most appropriate parameter for evaluating predation impacts from the hatchery operations.was the percentage of change in survival of juvenile sockeye or chinook salmon under the worst case conditions, compared to current baseline conditions. It is my belief that the assumptions developed by the scientific panel are an accurate portrayal of the predators and levels of predation based upon studies I've seen presented to the Anadromous Fisheries Committee over the past several years. The discussion of "Worst Case Scenario" in the DEIS adequately reflect the impacts to both juvenile sockeye and chinook in their lifehistories both in the Cedar River and Lake Washington. However, it is also important to recognize the positive benefit the "buffering" effect on predation will have as a result of the production of sockeye fry from the new hatchery. The release of sockeye fry will help minimize the predation on juvenile chinook because of a larger total number of salmon in the river at the same time. The scientific work group concluded that the potential for increased predation has a very low likelihood of occurring because of hatchery operations using worst case assumption. This is an area in which the AFC has and is spending significant monies to further assess the impacts to juvenile chinook and sockeye in Lake Washington. There will be more research done in this area in the future.
The scientists agreed that the hatchery is highly likely to have a neutral or minor effect s on the survival of chinook and sockeye, with a less than 5% chance of an adverse impact on survival. There will be ongoing review of information as it is developed

Specific Comments:Food Supply and Competition under the Worst Case

Scenario.
17 "The impacts of competition for food supply can be measured directly in the growth of juvenile chinook or sockeye salmon in Lake Washington". The scientists evaluation of "worst case assumptions" are based on numerous scientific studies. The scientists have considered the potential changes in prey abundance, overlapping utilization of prey during specific times of the year between chinook and sockeye juveniles and smolts and recognition of competition effects leading to increased mortalities of salmon. Given the scientific information which has been developed over the years by studies by agencies and the UW, the scientists have concluded that the project is expected to have a neutral effect on chinook salmon through increased competition in Lake Washington, resulting in a less than 5% reduction in survival. Additionally the sockeye are unlikely to be significantly affected by competition due to the abundance and composition of the prey in the lake. Chinook and sockeye do not share the same aquatic habitats nor diets. The present prey base does not appear to be a limiting factor for sockeye. If scientific monitoring via studies suggests that salmonid growth rates are declining, the AMP can call for an evaluation of adult returns and evaluating the cause of the decline. This is an appropriate action.

Specific Comments:Spawning Ground Competition Impacts under the Worst Case Scenario.
18 "The overall parameter considered for spawning ground competition between chinook and sockeye salmon was reduced chinook egg-fry survival." "he scientists concluded that the interaction between chinook and sockeye on the spawning grounds and selection spawning habitat shows that the sockeye appear to be primarily a "nuisance factor". The sockeye do not significantly
displace the chinook. The chinook move to avoid large numbers of sockeye however, the potential risk to chinook survival from spawning ground competition by sockeye salmon is low." The chinook redd surveys are funded by the King Conservation District and carried out by SPU and WDFW staff. Their observations are report on a weekly basis to the AFC during the migration and spawning periods and the information is available to the AFC, the AMWG, the TWG, the Independent Science Advisors and the MRP. Additionally, information is available to the "Parties" as well as co-managers. The activities demonstrated by the chinook in these situations are considered by the scientists as avoidance behavior rather than competition with the sockeye salmon and again it is a low potential risk to chinook survival.

19 Specific Comments:Superimposition.
"The overall parameter considered for superimposition impacts between chinook and sockeye salmon was reduced chinook salmon survival". Given the differentiation in size between chinook females and sockeye females, it is thought that the nest pocket of a chinook redd is to large for most sockeye to easily move and thus provides a protective barrier against sockeye digging activity. Female chinook activity following spawning protects the eggs during the sensitive embryo development stage. After roughly 10 days, the eggs are not susceptible to disturbance by female sockeye. The scientists concluded that the potential magnitude of impact to chinook eggs by female sockeye is low to non-existent.

Specific Comments:Cumulative Impacts.

20 The impacts of cumulative impacts as a result of the new sockeye hatchery are assumptions at best. The long term implications under a "Worst Case Scenario" are the most difficult to vision. This is due in part to the fact that the various topics of concern do not have significant impacts as individual components. The problem lies in what the future holds from a climatic perspective or a growth and development perspective or a changing level of predation or prey or any number of potential negative assumptions. However, all we can do is monitor and evaluate the change in existing conditions and react in an adaptive management role. The uncertainties do not warrant the elimination of the development and implementation of the Cedar River Sockeye Hatchery.

Specific Comments:Adaptive Management Plan

21 The inclusion of the Adaptive Management Plan is a critical element in the DEIS. The inclusion of an Adaptive Management Plan is a necessary vehicle in the development and implementation of the Cedar River Sockeye Hatchery. The need for such a monitoring and evaluation planning process was recognized in the origin HCP. SPU to its credit has continued to develop the AMP over the course of the years. They funded Adaptive Management Workshops in 2001 and 2002 following the initial assembly of the scientific advisory panel to help the City of Seattle develop plans to implement an effective, comprehensive and biologically sound artificial propagation program consistent with the Cedar River HCP. In Feb./March of 2005 they again funded another Adaptive Management Workshop which featured two of the best known experts in the field. They additionally held another internal meeting with one of these experts to focus specifically on how the staff, in charge of implementing the HCP programs, could understand the process to ask better questions about how to achieve goals and objectives necessary to be successful in implementing the Cedar River HCP. Stakeholders from the HCP Oversight Committee and Anadromous Fisheries Committee were also participants. It is clear that the City of Seattle is committed to successfully implementing all aspects of the Cedar River HCP.

22 The quality of this DEIS reflects the commitment of the City of Seattle and SPU to implement the goals and objectives of the HCP in the most successful manner. The quality of the DEIS also validates the science supporting the original FEIS. The implementation includes the successful development and implementation of the Cedar River Sockeye Hatchery. There is tremendous support for the Hatchery. The public has shown their support through attending numerous public forums, letters and contacts with City of Seattle political leaders, letters to the editor, articles in outdoor publications and conservation newsletters. There is clearly a demonstrated level of support EVERYTIME there is a sockeye fishing opportunity in Lake Washington.
The stories of the family bonding that occur during these time of fishing are told at every public meeting!

23 The Adaptive Management Plan is crucial in addressing the critical uncertainties associated with the development and implementation of Cedar River Sockeye Hatchery. Several of these critical uncertainties have been identified in this DEIS. They are important components to the DEIS and the HCP. They will make a better Sockeye Hatchery and HCP.

24 However, the scientists who have been chosen as salmon experts, to address the concerns raised by the Seattle Hearing Examiner have concluded that there is a low level of likelihood that the impacts of the new Cedar River Sockeye Hatchery will cause significant impacts to the Cedar River and Lake Washington basin.

25 Lets build the hatchery and implement the AMP as the tool to monitor and evaluate the science which is developed by the ongoing studies from the WDFW, FWS, the tribes, the Counties and other sources. The AMP and AMWP will be a public process and beneficial tool to make the Cedar River HCP, the best it can be. Lets build the Cedar River Sockeye Hatchery and move forward!!

Thank you for the opportunity to comment!

Bill Robinson
4600 SW Graham St.
Seattle, WA 98136-1455

Member of the Cedar River HCP Oversight Committee
Member of the Cedar River HCP Anadromous Fisheries Committee
Member of the SPU Adaptive Management Sub-committee

Responses to Comment Letter BR (Bill Robinson)

BR-1. Comment noted.

BR-2. Comment noted.

BR-3. Comment noted.

BR-4. Straying will be monitored under the AMP. If straying is determined to be causing impacts, the Parties can mandate changes in hatchery operation. Continued monitoring will suggest whether or not those changes reduce the impacts. The commenter's concern will be taken to the Adaptive Management Work Group as it is established.

BR-5. Comment noted.

BR-6. See Response 4 in this letter.

BR-7. Comment noted. Seattle Public Utilities has clearly identified and agrees that there are limitations associated with the interim hatchery facilities and that these limitations influence the program's ability to meet its goals. The replacement hatchery is being designed to overcome these problems and allow for more flexible management. For example, the replacement hatchery will be able to match incubation water temperature with that of the river water, resulting in more similarity in fry emergence timing between hatchery and naturally spawned fry. This is one of the ways that learning from the interim hatchery is being used to meet project goals. Operating protocols for the replacement hatchery are intended to maximize breeding diversity.

BR-8. Comment noted. The AMP identifies the need for additional genetic monitoring (Section 2.2.5). This comment will be forwarded to the Adaptive Management Work Group when it is established.

BR-9. Comment noted.

BR-10. Comment noted. The potential for low levels of straying into Bear Creek was discussed in Section 3.2.2.5 of the DSEIS.

BR-11. Comment noted. Anticipated straying rates for beach populations and the lack of data were discussed in Section 3.2.2.7 of the DSEIS.

BR-12. Section 2.4.2 of the FEIS discusses the origin of sockeye in the Cedar River. The recommendation raised by the commenter will be referred to the Adaptive Management Work Group when it is established.

BR-13. Comment noted.

BR-14. Seattle Public Utilities agrees that monitoring the fitness of naturally spawning sockeye is important, and it is identified as a key uncertainty in the AMP (Section 2.2). The issue of potentially unavoidable hatchery effects is being studied in several settings outside the Cedar River. Changes in design and management of hatcheries, as recommended by the HSRG, are focused on reducing the likelihood of such effects. Seattle Public Utilities has added Appendix C to provide an overview of the studies addressing these impacts to fitness.

BR-15. Comment noted. Seattle Public Utilities expects that the AMP will adjust the hypotheses and monitoring approaches over time as new learning occurs. This is one of the strengths of an adaptive management process.

The commenter correctly points out weaknesses of the interim hatchery, which the replacement hatchery will address.

BR-16. Comment noted.

BR-17. Comment noted.

BR-18. Comment noted.

BR-19. Comment noted.

BR-20. Seattle Public Utilities agrees that climate change and development pressures may change the context of the hatchery in the future. Monitoring under the AMP will help suggest management changes that may be needed in the future if these potential changes in context are realized.

BR-21. Comment noted.

BR-22. Comment noted.

BR-23. Comment noted.

BR-24. Comment noted.

BR-25. Comment noted.

To: Vikki Anselmo, Seattle Public Utilities, 700 5th Ave., Suite 4900, PO Box 34018, Seattle, WA 98124-4018

From: Sam Wright

Subject: Response to Cedar River Sockeye Hatchery Draft Supplemental EIS, February 2005

CONTEXT OF THE PROPOSED PROJECT - MISTAKES ALREADY MADE

At this stage in the environmental review process, it is essential to review the mistakes which were made in reaching the Landsburg Mitigation Agreement. While it may not be possible to correct these errors, it should at least be possible to prevent further mistakes from being added to the list. It is important to continually be aware of
1 the fact that the proposed sockeye hatchery is a *mitigation facility* that is suppose to mitigate the adverse environmental impacts from not allowing adult sockeye above Landsburg Dam - a responsibility that Seattle Public Utilities fought against for decades. It is not an *enhancement facility* where the only burden of proof would be a showing of net positive benefits from the hatchery project.

The most egregious error by the parties to the Landsburg Mitigation Agreement was expression of the mitigation agreement in terms of hatchery salmon fry. One lesson that should have been learned from mistakes made in past salmonid mitigation agreements is that any responsibilities should only be expressed in terms of net
2 sustainable increases in adult salmonid production. The three public agencies involved collectively lacked the institutional memory and technical expertise that should have prevented them from making this mistake. Their error is inexcusable given the advanced state of knowledge about hatcheries and salmonid mitigation at the time the agreement was negotiated. This error was then compounded when it was assumed that hatchery fish could be turned into comparable natural fish. The next mistake was substitution of an "Adaptive Management Plan" for any additional real mitigation responsibilities. The
3 "adaptive management" is merely the contemporary buzz words that stand for the research and monitoring programs that are typically attached to any salmonid mitigation responsibility. It is not legitimate "mitigation" by itself in any sense of the word.

The draft Adaptive Management Plan in the DSEIS makes it clear that Seattle Public Utilities will only accept numbers of fry produced as usable data for all future decision-making on the most critical and probably only important parameter of the
4 natural sockeye population, reproductive fitness. All other possible measures of reproductive fitness will be contested as being artifacts of "other variables". Seattle Public Utilities will continually stonewall any attempts to do otherwise that might somehow increase their mitigation costs. There is no point in even doing this work in the first place since the Landsburg Mitigation Agreement does not have any provision for
5 adding further real mitigation responsibilities, no matter how badly the hatchery project actually performs in practice.

None of the mistakes described above can be reversed since they are all part of
6 the Landsburg Mitigation Agreement. The only positive change potentially available at this point in time would be to seek a redirection of the millions of dollars in funding

6 currently specified for the Adaptive Management Plan. It could be much better spent on legitimate mitigation measures that produce tangible results.

CONFLICTS OF INTEREST

After carefully reviewing content of the FEIS and DSEIS, it has become obvious that Seattle Public Utilities should never have assumed Lead Agency status for this environmental Action. They are the party which inherited specific mitigation responsibilities as a result of their participation in the Landsburg Mitigation Agreement.
7 As such, they have an inherent financial conflict of interest in serving as the Lead Agency. The costs of mitigation are merely one item competing for finite funds available in the City of Seattle budget. There will always be intense internal pressures to minimize these costs as much as possible. The FEIS and DSEIS should be withdrawn. A new Lead Agency should be selected from among the three natural resource agencies that participated in the Landsburg Mitigation Agreement.

A subpart of the conflict of interest by Seattle Public Utilities lies in their selection of scientific consultants. A careful reading of the FEIS and DSEIS makes it clear that the scientist with the greatest influence on development of the project under consideration is Dr. Ernie Brannon. Dr. Brannon is well known within his profession for
8 his long and financially lucrative career working for anti-resource development interests. He is also the acknowledged champion of the impossible dream of turning hatchery fish into comparable wild fish and has promoted this concept repeatedly as an expert in opposition to existing or proposed Endangered Species Act listings throughout the Pacific Northwest. Seattle Public Utilities even references his most recent scientific paper (Brannon et al. 2004) which was partially developed with funding from anti-resource development interests. They also selected Dr. Brannon to lead the Worst Case Analysis Workshop panel that dealt with Threatened Puget Sound Chinook Salmon, whose listing he personally opposed.

ASSESSMENT OF DSEIS REPORT

This report, as well as the original FEIS, are unacceptable in their present form
9 and need to be withdrawn, revised extensively and submitted again for public review. However, Seattle Public Utilities will not be doing this and the next appropriate legal challenge will have to be on the combined "package". The obvious fatal flaw is the stubborn insistence on the part of Seattle Public Utilities in thinking that they can do the impossible by creating comparable wild fish from hatchery fish. They continue to claim that the most fundamental of all biological processes, natural selection, does not occur
10 (or can be fully mitigated) during several critical life history stages in which they plan to intervene with artificial production, which prevents natural selection. Thus, for example, the survival of each individual egg, alevin or fry during or subsequent to natural incubation is assumed to be a random event regardless of size of the egg, the depth to which it is buried, or the composition of the spawning gravel. The participants in the Worst Case Analysis Workshop made this same flawed assumption as did the Hatchery
11 Scientific Review Group (HSRG) - which Seattle Public Utilities frequently refers to in their attempts to gain credibility. These latter two groups may not have consciously realized that they were even making this assumption about random egg survival but it is

still obvious in their conclusions. A second major flaw is the continued belief by Seattle Public Utilities that sockeye redd superimposition on Threatened Puget Sound Chinook
12 salmon redds is probably not a significant problem, despite the fact that the ranges of their respective egg pocket depths overlap by about ten centimeters. The recent presence of large numbers of small, 3-year-old female chinook is also ignored.

The Worst Case Analysis and Workshop proved to be a complete waste of time because the probable or "best case analysis" was never even considered in any manner. It stands unchallenged as stated in the FEIS. However, numerous statements such as "the
13 hatchery would unavoidably remove some natural selection pressures" and "some reduction in fitness related to domestication is likely" (page 1-16) leave little doubt that Workshop participants would have found adverse environmental consequences from even the best case analysis. Seattle Public Utilities did not allow this to happen for obvious reasons. In addition, all of the worst case analysis work flowed from an
14 incorrect basic assumption that the interim hatchery program, which began in 1991, has had no significant adverse impacts on the sockeye populations.

The Adaptive Management Plan is also of little tangible value since it continues to be based on the same impossible assumptions described above. At this point, it merely
15 helps to perpetuate the myth or illusion that an Adaptive Management Plan plus the increased flexibility provided by the proposed hatchery (virus free water, fry holding capabilities, temperature control) and new broodstock collection facilities will effectively prevent any adverse environmental consequences from occurring. In common with the
16 worst case analysis work, the Adaptive Management Plan is also irretrievably flawed by the incorrect assumption of no significant adverse impacts from the interim hatchery program.

The proposed project, at this point in time, still presents a unique opportunity to correct a major mistake made in negotiation of the Landsburg Mitigation Agreement. Salmon hatchery programs have a long and notorious history of never fulfilling their original intended objectives (WDF. 1992. Salmon 2000 technical report. Phase 2: Puget Sound, Washington Coast and integrated planning. Olympia, WA). The
17 Northwest Regional Task Force Settlement Plan was developed in the late 1970s and was projected to increase the average annual State salmon catch from the mid-1970s average of 6.6 million fish to 14.5 million fish. This included a projected increase in Puget Sound sockeye catches of 489,000 fish annually, mainly from Cedar River production (WDF 1992:79). By the time this massive effort was finally evaluated in the early 1990s, less than 10% of the projected increase could be accounted for, and none of the Puget Sound sockeye (WDF 1992). Some of the same public agencies later participated in negotiations that led to the Landsburg Mitigation Agreement. It is now obvious that personnel who participated in these negotiations did not have the technical competence necessary to realize that they were trying to do something that was impossible (i.e., turn
18 hatchery fish into comparable wild fish without a significant reduction in reproductive fitness). The parties to the Agreement should not compound their mistakes even further by proceeding with the proposed mitigation project in its present form. The FSEIS should have a worst case analysis for the actual past track record of the parties - a 10% average realization of original expectations from hatchery projects. Thus, the project

18 would be expected to yield a net sustainable benefit equivalent to adding 3.4 million natural sockeye fry annually to the productivity of the system (10% of 34 million).

The proposed project also poses a special danger to the sockeye resource. In recent years, the average generation to generation replacement rate for natural production has fallen to a barely sustainable one to one ratio, and the most likely cause is the interim hatchery program which began in 1991. Seattle Public Utilities has argued that a whole host of complex interrelated and unfathomable factors might be involved in this significant decline in productivity. However, the only change which is known for certain
19 is establishment of the interim hatchery program and it has to become the prime suspect. The FSEIS should add another worst case analysis in which the interim hatchery program is assumed to be the primary cause of the recent decline in sockeye productivity from 1.6 to 1 (WDF 1992) down to the current 1 to 1 replacement rate. There is simply no surplus production left to gamble with if Seattle Public Utilities is allowed to proceed with their proposed project based on impossible assumptions. The natural population cannot accommodate a further reduction in reproductive fitness when it is barely replacing itself at the present time.

The Attachments were provided to Seattle Public Utilities during preparation of the DSEIS in hopes of persuading them to abandon the impossible directions which they
20 eventually elected to pursue. Since this effort was completely unsuccessful (as expected), please make the Attachments part of the Official Record so that they may be used during subsequent legal appeals of this project.

Seattle Public Utilities carefully filtered, manipulated, and suppressed the wealth of relevant scientific information available to them for preparation of the DSEIS. They
21 studiously avoided any information that did not conform to their preconceived positions, including virtually all of the information and references cited in my Attachments. This in turn allowed them to misrepresent the information which they did use. For example, the following statement appears on page 3-22: "Experience with the current sockeye hatchery provides some insight into the short-term effects of domestication. In brood year 1995, nearly all natural eggs in the Cedar River were eliminated by scour caused by high flow, and this resulted in an usually high proportion of hatchery fry leaving the Cedar River in 1996. Subsequent returns from this brood year and the subsequent brood year (1999) reproduced successfully in the river. While many factors influence survival, these progeny, from a group primarily composed of hatchery-origin fish, appear to have returned and spawned successfully and themselves produced progeny that were able to
22 survive and reproduce". It is not even appropriate to treat all of the spawners as if they were 4-year-old fish when any given spawning run is known to be composed of significant numbers of 3- to 5-year-old fish from three different consecutive brood years. The 1995 brood year of natural production sustained a severe degree of natural selection but still produced 730,000 fry (see Table 2-1, page 2-3). As expected from this severe natural selection, these fry produced the highest fry to adult survival rate of any natural group that was studied. They also had the largest average adult size at age of any group studied. The 5.1 million hatchery fry from this same brood year were protected from natural selection and, as expected, survived at a much lower rate and had a significantly lower average adult size at age. In this particular brood year, naturally produced fish demonstrated their greatest measured advantage over hatchery fish for fry to adult

22 survival. It is a classic example of the effects of natural selection and why Seattle Public Utilities is trying to do something that is impossible.

ADDITIONAL ASSESSMENT OF THE ADAPTIVE MANAGEMENT PLAN

23 Research and monitoring, or a form of untitled "adaptive management", began with initiation of the interim hatchery program in 1991. Many of the critical parameters described in the DSEIS as "unknown" are in fact "known". It is already known that hatchery fry are significantly smaller than wild fry when trapped at the mouth of the Cedar River (Dave Seiler, WDFW, personal communication), so the answer to this problem can definitely be changed from unknown to known.

24 The results provided by Fresh et al. (2002) in a draft report show that natural sockeye fry survive at two to three times the rate of hatchery fry, that the run timing has been changed by hatchery fish, and that hatchery fry produce adults that are smaller in average size at age (Fresh, K.L., S.L. Schroder, E.C. Volk, J. Grimm, and M. Mizell. 2002. Evaluation of the Cedar River sockeye hatchery: analysis of adult otolith recoveries. Draft. WDFW, Olympia, WA.). The in-river sampling for the studies involved was not properly stratified since the middle section was not sampled. However, there is no conceivable way that this could change the conclusion about reduced size at age for hatchery fish. Thus, it is definitely known that hatchery fish will have reduced fecundity and/or egg size as well as less physical capabilities with respect to depth of their egg pockets or use of larger, more stable spawning gravel. In addition, reduced size at age would be expected due to loss of natural selection at several life history stages with hatchery fish and is consistent with smaller hatchery fry being trapped at the mouth of the river and with results documented for other hatchery programs (which the FEIS and DSEIS consistently ignore).

25 The change in run timing had been expected and then known for years and was fully conceded in many discussions prior to the release of the Fresh et al. (2002) report. This is what has happened to every hatchery run on the Pacific Coast whenever the broodstock collection was skewed to the early part of the run. Again, the FSEIS must portray this parameter as known instead of unknown. However, unlike fry survival and adult size at age, this is a potentially correctable factor with capabilities of the proposed hatchery and new broodstock collection facilities.

26 The reduced survival rate of hatchery fry was also fully anticipated due to their smaller size, lack of natural selection, and the fact that this is a common feature of every other documented hatchery program (which the FEIS and DSEIS again ignore). The precision of these estimates could have been improved by properly stratified sampling but the general conclusion was certainly valid. Again, the FSEIS must be modified to reveal known facts.

27 The entire Adaptive Management Plan needs to be described in the proper context of beginning in the middle of a hatchery program, not at the beginning. Populations parameters that were not measured prior to initiation of the interim program need to be identified. More importantly, parameters that were not measured even during the tenure of the interim program need to be highlighted. As described above, a critical factor such as fecundity or egg size has already been modified to a sub-optimal level and

27 continuation of the hatchery program might simply perpetuate this significant decline in reproductive fitness.

28 The FSEIS also needs to reveal that WDFW has suppressed public release of any of the scientific information initially stated in Fresh et al. (2002) for over two years. The implication is that parties to the Landsburg Mitigation Agreement have not produced any usable scientific answers from costly, extensive studies dating back to 1991. This position in turn yielded many of the "unknowns" expressed in the current version of the Adaptive Management Plan. The past case history of hatchery evaluation work in the Cedar River casts serious doubts on the professional capabilities of the parties for conducting such work in the future. It does not matter how many new advisory groups are created since the final decision making still rests totally with the parties. Seattle Public Utilities cannot have it both ways. They can continue to call important issues unknown, which calls their ability to even handle the proposed project into question. Alternatively, they can admit that a great deal more is known about the hatchery program, and revise the FSEIS accordingly. Another worst case analysis needs to be added to the FSEIS in which it is assumed that the parties do not have the professional competence necessary to actually manage the proposed project.

29 It is obvious that the Adaptive Management Plan is doomed to never produce any usable results acceptable to Seattle Public Utilities due to the following critical assumption (page 2-2): "Due to the number of variables potentially affecting results, comparisons of fry to adult survival are not a useful method for evaluating relative fitness between hatchery and natural fry." We know from previous sections that hatchery fry are significantly smaller, that natural fry survive at two to three times the rate of hatchery fry and that hatchery fry produce smaller adults at the same ages. This smaller adults will have lower fecundity and/or egg size and reduced spawning capabilities. What the above assumption means is that even if the controversy over sampling stratification is resolved, any results will never be used for decision-making. Seattle Public Utilities will always have an alternative hypothesis to advance for any conceivable quantitative evidence of reduced reproductive fitness except for numbers of fry. The project will be allowed to proceeded unimpeded for 50 years without any agreed-to quantitative basis for determining fitness of hatchery fish. The proposed Adaptive Management Plan should be scrapped and the millions of dollars involved should be diverted to other mitigation measures that are capable of producing tangible benefits to the resource.

ADDITIONAL ASSESSMENT OF THE WORST CASE ANALYSIS

30 The Worst Case Workshop that provided the foundation for this exercise was very deceptive but certainly fooled any of the objective-minded participants. Observers could not reveal this deception at the time of the workshop since silence was a condition of their attendance. One major deception was a failure to reveal many of the facts known about the hatchery program as partially described in the previous sections. For example, the withholding of information produced the following conclusion statement which

31 appears on page 3-2: "Specific experiments demonstrating such reduction in fitness have not been conducted for Lake Washington sockeye salmon". Additional facts such as the egg pocket depth ranges for chinook and sockeye and the recent presence of large numbers of small 3-year-old female chinook were also withheld from participants. In

other cases, the participants did not have the necessary personal knowledge to even make certain judgments. Again, an example of this type of problem appears on page 3-2: "Consequently, the workshop participants recommended using the per capita production of downstream migrating fry as the index of fitness rather than returning adults." The
32 positive correlation between fry size and survival rate has been repeatedly documented in the scientific literature for decades as well as the fact that larger eggs produce larger fry. Thus, any objective participant who did not gain this knowledge on his own prior to the Workshop could be easily led to a wrong conclusion. If a participant had a definite bias to the Seattle Public Utilities position to begin with, then the lack of facts made it much easier to support their bias.

Another major deception was a complete lack of any consideration of the "best case" or expected condition as presented in the FEIS. The participants were only given a
33 complicated set of worst case assumptions that no human mind would be capable of properly assimilating in the complete absence of any best case assumptions. The net result observed was that many participants were making decisions on their limited understanding of the program in general. The most surprising result is that all of the participants eventually produced quantified percentages of expectations from information in which nothing was quantified. It was a very cleverly designed deception that fully met
34 its objectives. There is nothing to be gained from discussing implications of any specific parts of the Workshop reports since Seattle Public Utilities can now discount anything and everything as not being the expected project response.

To: Judith Noble

From: Sam Wright

Subject: Comments on Observations of the Worst Case Analysis Work Shop, April 29, 2004 (mainly Genetics Session).

One of the first thoughts that crossed my mind was that the structure of your effort was about what I would do if I wanted to get out of a commitment to build a hatchery. While I am sure that this is not your
35 intention, your approach merits a second examination even though it may seem to be too late. I suggest that you limit the detailed work in the DSEIS to the genetics and superimposition issues and then "act like you know what you are doing" with respect to responding to the problems raised by the Hearings Examiner.

The only important facet of the genetics issue is extent of the probable reduction in reproductive fitness. The question is no longer whether or not there will be a reduction but rather by how much. Thus, the "best case" is a moderate reduction that can clearly be mitigated by the hatchery program. The "worst
36 case" would be a severe reduction that could only be partially mitigated by the hatchery. Both of these present a logic problem since the hatchery is already mitigation for something else - not passing sockeye upstream. You now have to talk about the hatchery mitigating for itself. Some of the same fish will be "used twice".

There are two mechanisms which mandate some reduction in reproductive fitness. The first is that the hatchery cannot mimic natural mating behavior, especially the selection of larger males as mating partners by larger females. The hatchery and natural populations become significantly different at the fertilized egg stage of their like history. Egg to fry survival in the hatchery is high and any mortality is generally random. The egg to fry mortality is high and non-random in naturally spawned eggs. A higher percentage of larger eggs survive since they are, on average, buried deeper by larger fish in larger, more
37 stable spawning gravel. The larger eggs produce larger fry, which survive at a higher rate due to a lower rate of predation (fewer predators are big enough to eat them). Thus, by the time of fry emergence, the two populations have diverged even further apart. We know that these things happen because (1) hatchery fry are significantly smaller than natural fry when both are trapped at the mouth of the river by Dave Seiler's project; and (2) hatchery fish as adults are significantly smaller in size at age than naturally produced fish. It is highly likely that average egg size has declined from its optimum but this parameter was not measured before initiation of the interim hatchery program. The ability to have an unambiguous "control" is already lost.

Two short papers are attached that address the genetics and superimposition issues. They represent
38 early preliminary drafts of parts of my intended response to the public review version of the DSEIS. Considerable work with additional references remains to be done but they may be of some use to your current effort.

For the superimposition issue, the "best case" would be that chinook recover to meet their ESA
39 goals in spite of some modest adverse impacts from sockeye. The "worst case" would be that sockeye become one of the causes for chinook not recovering.

TURNING HATCHERY SALMON INTO WILD FISH: AN IMPOSSIBLE DREAM

Artificial production has been part of the salmon and steelhead picture for over a century and is a mandatory consideration in any fish population management work. The basic approach has recently split again into (1) the traditional century long production of fish to be caught by someone; and (2) a revived but impossible interest in turning hatchery fish into wild fish, commonly called "supplementation". Everyone involved in the latter is making two false assumptions. The first is that natural salmonid mating and redd protection behavior can be accurately simulated in a hatchery setting and the second is that salmonid egg incubation survival, while highly variable, is largely non-selective.

Any attempts to make effective wild spawners out of hatchery fish (supplementation) will continue to be in pursuit of an impossible dream. The natural mate selection and redd protection behavior of wild fish cannot be duplicated in a hatchery setting so the two salmonid populations (hatchery and wild) are significantly different while still at the fertilized egg stage of their life history (where overall genetic diversity reaches a peak). During natural salmonid egg incubation, this diversity is selectively diminished and differences between the two populations become even greater. At this point, hatchery fish will have much greater diversity (a common claim of supplementation supporters) but this is caused by undesirable attributes being artificially retained. No amount of tinkering with hatchery rearing practices can undue what has already occurred. Supplementation is not doomed to failure because it eliminates desirable survival attributes, it is doomed because it perpetuates other attributes as well.

The first true supplementation project that was adequately evaluated was with Tucannon River spring chinook. Bugert et al. (1992) cited significant changes observed in first generation hatchery fish (reduced size at age, fecundity at the same age, and age at maturity) as evidence of serious problems with a supplementation concept. However, Waples (1999) expressed surprise at these immediate (first generation) changes due to an inherent assumption that mortality during natural salmonid egg incubation, while high and variable, was largely non-selective. Results observed were entirely consistent with what would be expected from significant natural selection during mating and egg incubation. In a hatchery program for Cedar River sockeye, all fish were released as fry in a belief that two false assumptions described previously would keep them like wild fish. Hatchery fry survived at a much lower rate, were significantly smaller in size at age, and changed run timing (Fresh et al. 2002).

Survivors during natural salmonid egg incubation come from the deepest egg pockets (van den Berghe and Gross 1984; De Vries 1997) in larger, more stable spawning gravel (Burner 1951; Hawke 1978). The eggs were placed there by large females (Hankin and McKelvey 1985; Forbes and Peterman 1994) who deliberately select large males as their mating partners (Schroder 1981; Hankin et al. 1993) and are better at defending their nests against dig-up by other fish (van den Berghe and Gross 1989). These same females also have larger eggs (Hankin and McKelvey 1985; Beacham and Murray 1990; Heath et al. 2003) which produce fry with higher pre- and post-emergence survival rates (Shelton 1955; Forbes and Peterman 1994).

Net result of these processes is that large female salmonids have demonstrated a productivity that is much greater than can be explained by increase in fecundity alone. For coho, van den Berghe and Gross (1989) estimated that the largest females within a population had a 23-fold fitness advantage (measured to time of fry emergence) over the smallest females. Only about one-third of this reproductive differential was attributable to differences in fecundity. Helle (1989) compared the largest and smallest size-classes of chum salmon and found only a 1.2 fold difference in fecundity per parent but a fourfold difference in surviving offspring per parent.

The harsher the incubation conditions, the more intense natural selection processes become. Use of hatchery supplementation will always produce a significant decline in natural reproductive fitness (Bugert et al. 1992; Waples 1999; Fresh et al. 2002). No elements of new genetic diversity will be added and none will be eliminated when only local stocks are used. However, balance between desirable and undesirable attributes will be shifted to the latter. When non-local stocks are introduced, new attributes can be added but existing attributes are retained.

Egg size and burial depth and their positive correlation to female size are probably the most important considerations since data collected by Montgomery et al. (1996) suggest that small increases in scour depth (on the order of several centimeters) may seriously reduce incubation survival. DeVries 1997:1693) observed that: "Reduction in average fish size over time through selective fisheries may lead to

reduction or possibly eradication of a stock in streams where the prevailing scour depths favor larger individuals that are able to bury their eggs deeper". With respect to the proposed sockeye hatchery, the serious problem can be accurately described by adding "or hatchery programs" after "selective fisheries" in the above statement

A recent publication documented the rapid and declining evolution of egg size in captive chinook salmon (Heath et al. 2003). The main relevance to the current subject is that this decline was also seen in two Canadian chinook populations that were heavily supplemented with hatchery fish. In natural salmon populations, a balance between large and small eggs is achieved and normally maintained via by the process of non-directional evolution. Small eggs have the advantage of numbers but large eggs persist due to their higher average per egg survival rates. In the Cedar River sockeye population, the balance between large and small eggs has undoubtedly been de-stabilized to some degree in favor of the latter due to a decade-long interim hatchery program. Unfortunately, measurement of egg size was not a regular monitoring element. There is no way to measure the damage that has already been done unless the hatchery program is halted and the natural population is allowed over time to stabilize at its normal balance.

Additional information to be added from the following references:

Fowler, L.G. 1972. Growth and mortality of fingerling chinook salmon as affected by egg size. The Progressive Fish-Culturist 34(2):66-69.

Heath, D.D., C.W. Fox, and J.W. Heath. 1999. Maternal effects on offspring size: Variation through early development of chinook salmon. Evolution 53(5):1605-1611.

Quinn, T.P., A.P. Hendry, and L.A. Wetzel. 1995. The influence of life history trade-offs and the size of incubation gravels on egg size variation in sockeye salmon (*Oncorhynchus nerka*). Oikos (74):425-438.

References

Beacham, T.D., and C.B. Murray. 1990. Temperature, egg size, and development of embryos and alevins in five species of Pacific salmon: a comparative analysis. Transactions of the American Fisheries Society: 119:927-945.

Bugert, R., K. Peterson, G. Mendel, L. Ross, D. Milks, J. Dedloff, and M. Alexanderdottir. 1992. Lower Snake River compensation plan, Tucannon River spring chinook salmon hatchery evaluation plan. U.S. Fish and Wildlife Service, Boise, ID.

Burner, C.J. 1951. Characteristics of the spawning nests of Columbia River salmon. U.S. Fish and Wildlife Service Fishery Bulletin 61(52):97-110.

DeVries, P. 1997. Riverine salmonid egg burial depths: review of published data and implications of scour studies. Canadian Journal of Fisheries and Aquatic Sciences. 54:1685-1698.

Forbes, L.S., and R.M. Peterman. 1994. Simple size-structured models of recruitment and harvest in Pacific salmon (*Oncorhynchus* spp.). Canadian Journal of Fisheries and Aquatic Sciences 51:603-616.

Fresh, K.L., S.L. Schroder, E.C. Volk, J. Grimm, and M. Mizell. 2002. Evaluation of the Cedar River sockeye hatchery: analysis of adult otolith recoveries. Draft. Washington Department of Fish and Wildlife, Olympia, WA.

Hankin, D.G., and R. McKelvey. 1985. Comment on fecundity of chinook salmon and its relevance to life history theory. Canadian Journal of Fisheries and Aquatic Sciences 42:393-394.

Hankin. D.G., J.W. Nicholas, and T.W. Downey. 1993. Evidence for inheritance of age of maturity in chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 50:347-358.

Hawke, S.P. 1978. Stranded redds of quinnat salmon in the Mathias River, South Island, New Zealand. New Zealand Journal of Marine and Freshwater Research. 12:167-171.

Heath, D.D., J.W. Heath, C.A. Bryden, R.M. Johnson, and C.W. Fox. 2003. Rapid evolution of egg size in captive salmon. Science (299):1738-1740.

Helle, J.H. 1989. Relation between size-at-maturity and survival of progeny in chum salmon, *Oncorhynchus keta* (Walbaum). Journal of Fish Biology 35(Supplement A):99-107.

Montgomery, D.R., J.M. Buffington, N.P. Peterson, D. Schuett-Hames, and T.P. Quinn. 1996. Stream-bed scour, egg burial depths, and the influence of salmonid spawning on bed surface mobility and embryo survival. Canadian Journal of Fisheries and Aquatic Sciences 53:1061-1070.

Schroder, S. 1981. The role of sexual selection in determining overall mating patterns and mate choice in chum salmon. Ph.D. Dissertation, University of Washington, Seattle, WA.
Shelton, J.M. 1955. The hatching of chinook salmon eggs under simulated natural conditions. Progressive Fish-Culturist 17:20-35.
40 Van den Berghe, E.P., and M.R. Gross. 1984. Female size and nest depth in coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences 41:204-206.
Van den Berghe, E.P., and M.R. Gross. 1989. Natural selection resulting from female breeding competition in a Pacific salmon (coho: *Oncorhynchus kisutch*). Evolution 43:125-140.
Waples, R.S. 1999. Dispelling some myths about hatcheries. Fisheries 24(2):12-21.

SUPERIMPOSITION OF SOCKEYE SALMON REDDS

In Pacific salmon, each individual female digs a functional nest called a "redd" in a gravel stream bed. The female releases her eggs into the depression where they are fertilized simultaneously by one or more males. She then covers the eggs with a layer of gravel that is relatively free of sediments (DeVries 1997). The female normally deposits the eggs in several pockets, laid in an upstream progression within a single redd. The eggs settle among the crevices of the redd bottom during the spawning act. For chinook salmon, the number of eggs tend to decrease as successive pockets are created, with the greatest number usually found in the deepest, downstream pockets of the redds (Hawke 1978). The differences in egg pockets depths for the same female can be as much as 22 cm (Hawke 1978). The decrease in egg pocket burial depth probably occurs over time as the female expends her energy. In addition, the female is only digging deep enough to bury her last eggs (DeVries 1997).

There is a strong correlation between fish size and egg burial depth. Clearly, larger females can bury their eggs at a greater depth than smaller females (DeVries 1997). Larger fish or species can also use deeper and faster water and larger gravel than smaller individuals. Larger females have greater strength and mechanical advantage over smaller ones. This normally maintains an obvious spatial separation between chinook and sockeye salmon when they occur in the same stream. There are apparently no studies or even observations of significant sockeye superimposition on chinook redds in any stream system along the Pacific Coast - except for the Cedar River. The main reason it occurs here is that smaller, 3-year-old female chinook spawners were not present in the past but are now commonplace.

The DSEIS perpetuates the erroneous assumption of state and federal agencies that there has never been any significant change in the size and age structure of Puget Sound chinook populations. However, a century of massive hatchery releases and selective fishing regimes against older fish, females, and larger individuals of the same age have caused an important change that needs to be acknowledged (WDFW 1992,1997; Wright 2002). Gilbert (1912:64) reports as follows: "From salt-water in Puget Sound, we have secured immature third-year fish, both males and females, *and also matured third-year males*, taken by purse-seines from the same school, and both feeding voraciously and equally on small sand-lance and
41 young herring. There was no difference is size between the mature and immature individuals, nor could they be externally distinguished, unless by a certain distension of the abdomen in mature specimens, due to the developed testes. It became evident from our observations: (1) that a very small proportion of the males of a given year develop precociously; (2) that precocity is apparently not caused by the influence of peculiar external conditions operating upon the individuals thus affected, but by some unknown factor; (3) that precocious development does not stunt the growth. *No mature female king salmon less than four years old have thus far been encountered.*" (emphasis added). Doubters may attempt to dismiss this early work with a claim of inadequate sampling but it is important to note that the same author (Gilbert 1912) documented the presence of significant numbers of mature 3-year-old female chinook in California and in the Columbia River system. Major hatchery programs had already been established in both areas prior to the time of sampling

DeVries (1997:Table 2, p.1695) states that the depth of the top of the chinook egg pockets (below the original stream bed level) will be 15cm or greater while the maximum depth to the bottom of the chinook egg pockets will be 50cm. The comparable numbers for sockeye salmon will be 10cm and 25cm, respectively. Thus, it can be concluded that chinook eggs buried at a depth of 25cm or greater should be safe from any subsequent sockeye redd construction disturbance. However, any chinook eggs buried at depths between 15cm and 25 cm are at risk of loss due to mechanical crushing and washing out of eggs.

Seiler et al. (2003) estimated that the Cedar River produced 81,000 wild chinook fry and fingerlings in 1999 and another 65,000 in 2000. In the same two years, they estimated that Bear Creek produced 15,000 and 32,000 wild chinook fry and fingerlings, respectively. However, this wild fish production in key Lake Washington tributaries is far below the planned annual hatchery releases of 2.265 million fingerlings. It can be anticipated that there will continue to be large numbers of small, 3-year-old female chinook spawning in the Cedar River.

In addition, all of the indigenous chinook populations in Puget Sound (including the Cedar River) appear to have current juvenile production that is far below their potential due to inadequate adult spawning escapements (both in total numbers and in excessive proportions of hatchery origin fish). In two of 12 years of record, the Skagit River demonstrated the ability to produce six million wild fry and fingerlings but the average was only 2.8 million (Seiler et al. 2002b). For comparative purposes, a relatively modest sized

Washington coastal river basin of only 245 square miles (then without a hatchery), was estimated at the 95 percent confidence level to have produced between 1.8 and 4.0 million wild chinook fingerlings in 1972 (Wright et al. 1973). Thus, the Cedar River does not have any significant chinook "Surplus Production" for harvest much less sacrifice to massive numbers of hatchery sockeye spawners.

It is realized that hatchery chinook fingerlings will survive at significantly lower rates than wild chinook and that the initial tremendous numerical advantages of hatchery fish over wild fish will be diminished. However, this will be countered by the fact that numbers of wild chinook juveniles will include both fry and fingerlings, whereas hatchery fish are only fingerlings and these are significant larger than wild fingerlings. The anticipated net effect can be seen in areas such as the Green River where it was recently estimated that 71% of the fish spawning naturally came from hatchery origin parents (Seiler et al. 2002a). A similar or higher percentage of hatchery chinook can be expected in the Cedar River in the foreseeable future.

A January 5, 2000, memo from Steve Smith of NOAA Fisheries states as follows (page 3): "G) Under the broad definition of ESA, "take" of listed species will include hatchery activities that lead to harassment, behavioral modification, capture, handling, tagging, bio-sampling, rearing, release, competition, predation, disease transfer, adverse genetic effects, injury, or mortality of listed fish. When "take" of a listed species is expected in the hatchery operation, *the ESA requires that a numerical estimate be quantified as best as possible. To meet this objective, a "take table" is appended to the HGMP that, when completed for each hatchery program, will provide a uniform means to report estimated take (see Table 1)*" (emphasis added). An obvious violation of this requirement occurs with the existing and planned sockeye hatchery programs.

A recent publication documented the rapid and declining evolution of egg size in captive chinook salmon (Heath et al. 2003). The main relevance to the current subject is that this decline was also seen in two Canadian chinook populations that were heavily supplemented with hatchery fish. In natural populations, a stability or optimum situation is normally reached between large and small eggs (non-directional evolution). The small eggs have an obvious advantage of greater numbers, while large eggs can only persist if they have a definite survival advantage on a per egg basis. Egg size needs to be added as a monitoring element for chinook since the hatchery program will probably de-stabilize the balance between large and small eggs in favor of the latter. This will be especially important if, as currently planned, egg takes depart from past practices and are limited to marked (hatchery origin) fish. This will significantly accelerate the evolution toward smaller egg size.

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There are only a few years in which chinook egg to migrant survival rates were measured following spawning seasons in which sockeye redd superimposition rates were also measured. It happened to be a coincidence that the highest chinook survival rate (17%) was measured following the highest rate of sockeye redd superimposition. The 17% rate was mainly a product of two things. First, there was no severe flooding during egg incubation to blow eggs out of the gravel or even expose the bridging layers above the egg pockets to excessive sand and silt deposits. The second factor was abnormally high river flows during the juvenile chinook out-migration and it is well-known that this will significantly reduce the predation rates on these small fish (just as it does for sockeye fry).

References

DeVries, P. 1997. Riverine salmonid egg burial depths: review of published data and implications of scour studies. Canadian Journal of Fisheries and Aquatic Sciences. 54:1685-1698.
Gilbert, C.H. 1912. Age at maturity of Pacific coast salmon of the genus *Oncorhynchus*. Bulletin U.S. Fish Commission 32:57-70.
Hawke, S.P. 1978. Stranded redds of quinnat salmon in the Mathias River, South Island, New Zealand. New Zealand Journal of Marine and Freshwater Research. 12:167-171.
Heath, D.D., J.W. Heath, C.A. Bryden, R.M. Johnson, and C.W. Fox. 2003. Rapid evolution of egg size in captive salmon. Science (299):1738-1740.
Seiler, D., G. Volkhardt, L. Kishimoto, and P. Topping. 2002a. 2000 Green River juvenile salmonid production evaluation. Washington Department of Fish and Wildlife. Olympia, WA.
Seiler, D., S. Neuhauser, and L. Kishimoto. 2002b. 2001 Skagit River wild 0+ chinook production evaluation. Washington Department of Fish and Wildlife. Olympia, WA.

Seiler, D., G. Volkhardt, and L. Kishimoto. 2003. Evaluation of downstream migrant salmon production in 1999 and 2000 from three Lake Washington tributaries: Cedar River, Bear Creek, and Issaquah Creek. Washington Department of Fish and Wildlife. Olympia, WA.
Washington Department of Fisheries (WDF). 1992. Salmon 2000 technical report. Phase 2: Puget Sound, Washington coast and integrated planning. Washington Department of Fisheries, Olympia, WA.
Washington Department of Fish and Wildlife (WDFW). 1997. Final environmental impact statement for the Wild Salmonid Policy. Washington Department of Fish and Wildlife, Olympia, WA.
Wright, S., M. Fraidenburg, and R. Brix. 1973. Observation and marking of juvenile chinook salmon in the Humptulips River, Washington. The Progressive Fish-Culturist 35(3):154-156.
Wright, S. 2002. A perspective on harvest-related elements that must be addressed in order to achieve the recovery of naturally spawning Puget Sound chinook salmon. Prepared for Washington Trout, Duvall, WA.

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To: Chief, Protected Resources Division, NMFS, 525 NE Oregon Street - Suite 500, Portland, OR., 97232-2737

From: Sam Wright, 2103 Harrison NW, Suite 2126, Olympia WA., 98502 (phone 360-943-4424) (e-mail: sam.wright@worldnet.att.net)

Subject: Additional Comments on Proposed Policy on the Consideration of Hatchery-Origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead. Additional Comments on Proposed Listing Determinations for 27 ESUs of West Coast Salmonids.

It is necessary to supplement my original comments on the documents cited above due to publication of a lengthy article on the subject that recently appeared in the September issue of ***Fisheries***.
42 The report, herein cited as Brannon et al. (2004), did an excellent job of largely diffusing the problems associated with "traditional" hatchery fish complaints such as disease transmission considerations, use of non-indigenous fish for hatchery brood stock and use of hatchery fish with the wrong run timing.

However, Brannon et al. (2004) eventually conclude that hatchery supplementation of wild salmonid populations will be successful in creating comparable fish as long as the brood stock is composed of indigenous fish with the same run timing as wild fish. It takes a very careful reading of Brannon et al. (2004) to determine that their entire hypothesis is based on a number of incorrect and unsupported assumptions. First, they are assuming that natural mating and nest protection behavior can be simulated in a hatchery setting. Next, they assume that natural egg incubation mortalities are random events. This is
43 followed by an assumption that early fry and fingerling mortalities are also random events. Finally, they are assuming that any observed differences in returning hatchery origin fish were due to hatchery juvenile rearing practices that can subsequently be modified to correct the problem. The inherent situation that allows these types of assumptions to be asserted is that indigenous hatchery fish do not have any unique genetic "markers" that can be used to directly measure differences in survival between hatchery and wild fish or to detect genetic introgression into wild populations.

In the attached report, an alternative hypothesis is presented and, unlike Brannon et al. (2004), substantial direct and indirect non-genetic evidence is provided in support of that hypothesis. What Brannon et al. (2004) claim is not only unsupported by any empirical evidence, but is, in fact, impossible. There are
44 fundamental differences between the hatchery and wild populations beginning in the first generation and these cannot be corrected by any conceivable modification of any hatchery practices, including juvenile rearing procedures. The two populations are significantly different before juvenile rearing even begins in any hatchery.

ANOTHER PERSPECTIVE ON THE SALMON HATCHERY CONTROVERSY

In salmonid resource management, hatchery fish definitely have a legitimate place in providing fish for harvest, in introducing or re-introducing fish into suitable habitats and in providing a last but temporary resort for the preservation of unique genetic resources or discrete populations (1). Hatchery fish do not have a legitimate place in programs where they become mixed to a high degree with existing wild fish populations as juveniles and on the spawning grounds. In these cases, a significant reduction in natural reproductive fitness is guaranteed and the only question to debate is whether or not a given hatchery program can even mitigate its own adverse impacts on wild salmonid populations, including cross-species impacts (2,3,4). The fact that hatchery programs produce additional natural spawners is meaningless by itself. The true
45 test is whether or not naturally spawning fish of mixed hatchery and wild origin begin replacing themselves at something significantly greater than a one to one basis.

Artificial production has been part of salmonid management for well over a century and is a mandatory consideration in any fish population management work (1). The basic approach has recently split again into the traditional century plus production of fish to be caught by someone, and a revived but impossible interest in turning hatchery fish into wild fish, commonly called "supplementation" ("integrated" and "mixed" are also used). The newest buzz words for supplementation are "genetically similar", even though the majority of past failures were with genetically similar hatchery fish (5). Scientists currently championing this version of supplementation, as well as their detractors, are both making two incorrect assumptions. The first is that natural salmonid mating and nest (redd) protection behavior can be accurately simulated in a hatchery

setting and the second is that natural salmonid egg incubation survival, while much lower than in a hatchery and highly variable (about 1 to 30%), is largely non-selective. In combination, these two assumptions lead proponents and opponents alike to a belief that any potential problems with hatchery fish cannot be manifested until at least the second generation (2,3,5).

Any attempts to make effective wild spawners out of hatchery fish will continue to be in pursuit of an impossible dream because adverse impacts from hatchery fish actually begin with the first generation. The natural mate selection and redd protection behavior of wild fish cannot be duplicated in a hatchery setting so the two salmonid populations are significantly different while still at the fertilized egg stage of their life history (where overall genetic diversity reaches a peak). During natural salmonid egg incubation, this diversity is selectively diminished and differences between the two populations become even greater. At this point, hatchery fish will have much greater diversity (a common claim of supplementation supporters as well as landscape development interests) but this is caused by undesirable attributes being artificially retained. No amount of subsequent tinkering with hatchery juvenile rearing practices can undue what has already occurred. Supplementation is not doomed to failure because it eliminates desirable survival attributes, it is doomed because it perpetuates other attributes as well. In spite of over a century of repeated failures, each new generation of hatchery advocates always tries to do the impossible. They prove to be elusive, moving targets. By the time any seemingly new approach becomes recognized as an acknowledged failure, the approach has been tweaked to become yet another "new" methodology (5).

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The first true supplementation project that was adequately evaluated was with Tucannon River spring chinook salmon. Significant changes observed in first generation hatchery fish (reduced size at age, reduced fecundity at the same age, and younger average age at maturity) were cited as evidence of serious problems with a supplementation concept. However, surprise was expressed at these immediate (first generation) changes due to an inherent assumption that mortality during natural salmonid egg incubation, while high and variable, was largely non-selective (2). Results observed were entirely consistent with what would be expected from significant natural selection during mating and egg incubation. In a hatchery program for Cedar River sockeye salmon, all fish were released as fry in a belief that two false assumptions described previously would keep them like wild fish. Hatchery fish were smaller than wild fry when trapped at the mouth of the river, survived at a much lower rate, were significantly smaller in adult size at age, and changed run timing (6).

Survivors during natural salmonid egg incubation come from the deepest egg pockets (7,8) in larger, more stable spawning gravel (9,10). The eggs were placed there by larger females (11,12) who deliberately select larger males as their mating partners (13) and are better at defending their nests against dig-up by other fish (14). These same females also have larger eggs (11,15,16) which produce fry with higher pre- and post-emergence survival rates (12,17).

Net result of these processes is that large female salmonids have demonstrated a productivity that is much greater than can be explained by increase in fecundity alone. For coho salmon, it was estimated that the largest females within a population had a 23-fold fitness advantage (measured to time of fry emergence) over the smallest females

(14). Only about one-third of this reproductive differential was attributable to differences in fecundity. When the largest and smallest size-classes of chum salmon were compared, it was found that there was only a 1.2 fold difference in fecundity per parent but a fourfold difference in surviving offspring per parent (18).

The harsher the incubation conditions, the more intense natural selection processes become. Use of hatchery supplementation will always produce a significant decline in natural reproductive fitness (2,3,4). No elements of new genetic diversity will be added and none will be eliminated when only local stocks are used. However, balance between desirable and undesirable attributes will be shifted to the latter. When non-local stocks are introduced, new attributes can be added but existing attributes are retained.

Egg size and burial depth and their positive correlation to female size are
45 important considerations since data suggest that small increases in scour depth (on the order of several centimeters) may seriously reduce incubation survival (19) It was observed that: "Reduction in average fish size over time through selective fisheries may lead to reduction or possible eradication of a stock in streams where the prevailing scour depths favor larger individuals that are able to bury their eggs deeper." (8). With respect to the hatchery programs at issue, the serious problem can be accurately described by adding "and/or hatchery programs" after "selective fisheries" in the above statement.

Recent studies documented the rapid and declining evolution of egg size in captive chinook salmon (16). The main relevance to the current subject is that this decline was also seen in two Canadian chinook populations that were heavily supplemented with hatchery fish. In natural salmon populations, a balance between large and small eggs is achieved and normally maintained via the process of non-directional

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evolution. Small eggs have the advantage of numbers but large eggs persist due to their higher average per egg survival rates. Average egg size and the distribution of egg sizes reaches stability at an optimum situation in naturally spawning salmonid populations. This is determined mainly by environmental characteristics of the spawning gravel habitat in any given system (8,20). When an infusion of hatchery fish disrupts this optimum situation in either direction, reproductive fitness can only decline. Larger eggs produce larger fry and these will survive, on average, at a higher rate during and subsequent to incubation. One study found that smaller fry made up their disparity in size but this required greater feeding activity and exposure to predation risks (21). However, an earlier study had found that the smaller fry from smaller eggs never made up their initial disparity in size (22). The end result would be the same in both cases -
45 larger fry survive at a higher average rate.

The adverse impacts of hatcheries can be complex. For example, there is a common and long-term assumption that there has never been any significant change in the size and age structure of Endangered Species Act (ESA) listed Puget Sound chinook salmon populations (23). In reality, the combination of hatchery practices and selective fishing against older fish have caused detrimental changes. In the early 1900s, it was reported as follows: "From salt-water in Puget Sound, we have secured immature third-year fish, both males and females, *and also matured third-year males,* taken by purse-seines from the same school, and both feeding voraciously and equally on small sand-lance and young herring. There was no difference is size between the mature and immature individuals, nor could they be externally distinguished, unless by a certain distention of the abdomen in mature specimens, due to the developed testes. It became

evident from our observations: (1) that a very small proportion of the males of a given year develop precociously; (2) that precocity is apparently not caused by the influence of peculiar external conditions operating upon the individuals thus affected, but by some unknown factor; (3) that precocious development does not stunt the growth. *No mature female king salmon less than four years old have thus far been encountered.*" (emphasis added) (24). Doubters may attempt to dismiss this early work with a claim of inadequate sampling but it is important to note the same author (24) documented the presence of significant numbers of mature 3-year-old female chinook in California and in the Columbia River system. Major hatchery programs had already been established in both areas prior to the time of sampling. It does not appear that any reliance should be placed on third-year females for the recovery of Puget Sound chinook since this particular life
45 history strategy failed to be successful in centuries of evolution. If the strategy could not be successful under natural habitat conditions, it is certainly not going to be viable in this era of dramatic increases in both the frequency and amplitude of flood events (23). Three-year-old females are not currently a significant part of the reproductive element in the Skagit River and this is the only river basin in Puget Sound where wild fish are not overwhelmed by hatchery fish as both juveniles and adult spawners (23).

There is a similar case history of adverse impacts from hatchery steelhead in Washington but the profound changes in size and age structure of hatchery fish are commonly recognized (25). Impacts to wild populations are partially mitigated by the earlier average run timing of hatchery steelhead and their much higher harvest rates. However, there has been significant genetic introgression into a number of wild steelhead populations (25). Steelhead fisheries managers in Washington commonly exclude

hatchery origin natural spawners in their work with spawner-recruit relationships. This reflects a complete lack of confidence in the value of hatchery steelhead as natural spawners.

A group of scientists recently took a strong position against the inclusion of hatchery fish in ESA listed Evolutionarily Significant Units (ESUs)(26). They actually underestimated the nature of the problem by stating that adverse effects could not appear until at least the second generation (see above). Unfortunately, their solution is not feasible given the current legal and political situation. Instead, the National Marine Fisheries Service (NMFS) has proposed a new policy stating that any indigenous salmonid population or ESU can be preserved indefinitely by hatchery programs as long as there is a token infusion of "naturally spawned" brood stock (hatchery advocates call
45 these "feral fish"). The proposed policy needs to be modified to clearly specify the three legitimate uses of hatchery fish: producing fish to be harvested, introductions or re-introductions into suitable habitats, or a temporary last resort to preserve valuable genetic resources. Hatchery programs called supplementation, integrated or mixed should be clearly labeled as such. It is impossible to turn hatchery fish into comparable wild fish with this approach and it will not add anything positive to the future preservation of individual fish populations or ESUs. Hatchery programs with "genetically similar" fish should be ESA-listed in all areas where indigenous wild populations still exist. However, the primary purpose for their listing would be directed monitoring and management by NMFS to insure that these hatchery programs are effectively mitigating, on a sustainable basis, their adverse impacts on the reproductive fitness of wild populations, including other salmonid species (27). Hatchery populations should not be ESA-listed in any areas

where the indigenous populations no longer exist (i.e., are judged to be "genetically extinct")(23,27). Listings could be considered in the future if there is evidence that indigenous populations still exist.

References and Notes

1. National Research Council, *Upstream: Salmon and Society in the Pacific Northwest* (National Academy Press, Washington, DC, 1996).
2. R.S. Waples, *Fisheries* **24**, 12 (February 1999).
3. R. Hilborn, J. Winton, *Can. J. Fish. Aqua. Sci.* **50**, 2043 (1993).
4. S. Wright, *N. Am. J. Fish. Mgmt.* **1**, 29 (1981).
5. E.L. Brannon, *et al.*, *Fisheries* **29**, 12 (September 2004).
6. K.L. Fresh *et al.* Evaluation of the Cedar River sockeye hatchery: analysis of otolith recoveries. WDFW, Olympia, WA. (2002).
7. E.P van den Berghe, M.R. Gross, *Can. J. Fish. Aqua. Sci.* **41**, 204 (1984).
8. P. DeVries, *Can. J. Fish. Aqua. Sci.* **54**, 1685 (1997).
9. C.J. Burner, *USFWS Fish. Bull.* **61**(52), 97 (1951).
10. S.P. Hawke, *New Zealand J. Mar. Fw. Res.* **12**, 167 (1978).
11. D.G. Hankin, R. McKelvey, *Can. J. Fish. Aqua. Sci.* **42**, 393 (1985).
12. L.S. Forbes, R.M. Peterman, *Can. J. Fish. Aqua. Sci.* **51**, 603 (1994).
13. D.G. Hankin, *et al.*, *Can. J. Fish. Aqua. Sci.* **50**, 347 (1993).
14. E.P. van den Berghe, M.R. Gross, *Evolution* **43**, 125 (1989).
15. T.D. Beacham, C.B. Murray, *Trans. Am. Fish. Soc.* **119**, 927 (1990).
16. D.D. Heath, *et al.*, *Science* **299**, 1738 (2003).

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17. J.M. Shelton, *Prog. Fish-Cult.*, **17**(1), 20 (1955).
18. J.H. Helle, *J. Fish Bio.* **35**(Supp. A.), 99 (1989).
19. D.R. Montgomery, *et al.*, *Can. J. Fish. Aqua. Sci.* **53**, 1061(1996).
20. T.P. Quinn, *et al.*, *Oikos* **74**, 425 (1999).
21. D.D. Heath, *et al.*, *Evolution* **53**, 1605 (1999).
22. L.G. Fowler, *Prog. Fish-Cult.* **34**(2), 66 (1972).
23. J. M. Myers, *et al.* Status review of chinook salmon from WA., OR., ID., and CA. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-35.
24. C.H. Gilbert, *Bull. U.S. Fish. Comm.* **32**, 57 (1912).
25. P.J. Busby, *et al.* Status review of west coast steelhead from WA., OR., ID., and CA. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-27.
26. R.A. Myers, *et al.*, *Science* **303**, 1980 (2004).
27. S. Wright, *Fisheries* **18**, 3 (May 1993).

Responses to Comment Letter SW (Jim Wright)

SW-1. Comment noted. The comment addresses an issue that is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please refer to General Response No. 1

SW-2. Comment noted. The comment addresses an issue that is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please refer to General Response No. 1

SW-3. Comment noted. The comment addresses an issue that is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please refer to General Response No. 1.

SW-4. The variety of monitoring variables that will be used to evaluate changes in reproductive fitness are described in the AMP (see Sections 2.2.3 through 2.2.5). The rate at which fry are produced by natural spawners would be only one measure of fitness. It would be considered with return per spawner numbers and other measures to evaluate trends in fitness, and to compare hatchery and naturally produced fry by brood year.
Other indicators of survival and fitness, including pre-smolt assessments, spawner to return rates, body size, fecundity, total egg weight, spawning date and location and egg size are proposed to complement the fry per spawner analysis.

SW-5. Comment noted. The comment addresses an issue that is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please refer to General Response No. 1.

The AMP, part of the LMA, makes provision for responding to monitoring results and lays out a clear process for doing so. These responses include additional monitoring, changes in hatchery management practices, or, in the extreme, closing the hatchery. Please see Section 4.8 of the AMP. The LMA also lays out how alternative mitigation would be selected.

SW-6. Comment noted. The comment addresses an issue that is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please refer to General Response No. 1.

Seattle Public Utilities considers the funding for the monitoring program and adaptive management necessary to address uncertainties regarding sockeye production and potential effects.

SW-7. Comment noted. The comment addresses an issue that is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please refer to General Response No. 1.

As the department within the City responsible for the replacement hatchery project, SPU is appropriately the lead agency for SEPA purposes. Cost commitments including funding for the replacement hatchery are prescribed in the HCP and define the City's funding obligations. Please refer to General Response No. 5.

SW-8. Dr. Brannon is one of 16 scientists who took part in the worst case analysis workshop. He led one of three concurrent sections in the workshop (superimposition and competition for spawning sites). Others who led workshop segments were Dr. Thomas Quinn and Dr. Dave Beauchamp. Refer to General Response No. 3 for more information on the selection of participants for the workshop.

SW-9. Comment noted. This comment presents legal argument that is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please refer to General Response No. 1.

SW-10. The issue of comparability of hatchery and wild-spawned fish continues to be a subject of debate. We have added language to the FSEIS in Chapter 3, Section 3.2.4.3 and included Appendix C to provide the reader with additional information on the potential effects of hatcheries on fitness.

Seattle Public Utilities acknowledges the differences in selection pressures that occur on fish that spawn in the natural environment and those that are spawned in a hatchery, and has concluded that such differences will result in some effect on fitness. For example, see the third paragraph in Section 3.2.4.1 of the SEIS, which states that hatcheries have intrinsic effects on the genetics of the fish that are produced due to, "removing selection pressures during the spawning and egg incubation phases". The level of impact, however, is uncertain.

One of the objectives of the worst case analysis workshop was to describe and disclose for decision-makers the level of change that potentially could occur. Participants in the worst case analysis workshop concluded that some level of domestication and reduction in fitness was likely because the hatchery would unavoidably remove some natural selection pressures. However, SPU hypothesizes that some impacts may be minimized or avoided by hatchery design and management practices. Planned changes from the interim hatchery include: limiting production with the goal of maintaining hatchery returns below 50 percent of the run; using a random mix of broodstock; allowing most hatchery returns to encounter selection pressures; and minimizing the time fry spend in the hatchery so that hatchery origin fish experience natural selection pressures for most of their lives.

SW-11. Comment noted. Also refer to Response 10 of this letter.

SW-12. Using available data, low Chinook production in the Cedar River and high superimposition rates do not appear to be correlated, although a number of environmental factors could obscure the relationship (see FEIS addendum, p. 3). Superimposition was evaluated in the worst case analysis workshop, and the participating scientists concluded that the risks of a significant impacts were minimal. This conclusion is based on the collective judgments of biologists on the panel that evaluated this issue. However, there are differing views on the potential for interactions between sockeye and Chinook. Burton et al. (2004) predicted increasing interactions with higher sockeye abundance, which could occur more frequently with additional hatchery production. The SEIS (Section 3.6.2.4) and FEIS (p. 2.4-31) discuss that some loss of Chinook eggs could occur. Also refer to Letter TT, Response 48.

Regarding Chinook females, 3-year-old females comprised 29 percent, 3 percent, and 8 percent of the total females for sampling years 2001 through 2003, respectively, as determined by aging scale samples from carcasses (see reference for Burton et al. 2004, Section 5, Literature Cited, in the AMP). Two years of data are currently available to evaluate the origin of 3-year-old female Chinook. In 2002, marked hatchery strays from other areas made up 20 percent of the age 3 female Chinook, while in 2003 they comprised 50 percent of the return of age 3 females. From these data, it appears that 3-year-old Chinook represent a small fraction of the spawning females in two of three years, and that strays from Chinook hatcheries are contributing to the number of 3-year-old female spawners in the Cedar River. This information became available only after the worst case analysis workshop was completed, but it provides further support for the conclusion of the worst case analysis panel on the effects of superimposition.

SW-13. The workshop was focused on following the Hearing Examiner's direction, and not on developing a best case analysis. The direction of the Hearing Examiner was to develop a worst case analysis for specified potentially significant impacts including genetic impacts, competition for food supply, and impacts from superimposition (see Hearing Examiner's decision, Conclusion 13). The workshop assumed current conditions as a baseline and discussed whether or not current conditions would deteriorate based on an increase in the number of sockeye fry using the lower river.

SW-14. This was not one of the assumptions provided to workshop participants, nor was it made by any of the groups. Seattle Public Utilities has clearly identified and agrees that there are issues with the current interim hatchery that increase the importance completing the replacement facility so that known deficiencies with the interim facility can be corrected. Available studies on hatchery and naturally spawning fish were made accessible to scientists participating in the SEIS worst case analysis workshop and were an important component of the findings of this workshop that are documented in the SEIS. Baseline conditions for worst case analysis were assumed to be current conditions for predation and competition analyses. The worst case workshop addressed what changes in baseline conditions might be expected with a projected maximum increase in the number of hatchery fish by 17 million fry. The

genetics group assessed the impacts relative to a wild population as their baseline condition. In addition, key scientists involved in the monitoring and evaluation of the interim hatchery participated in the worst case analysis workshop, providing the opportunity for unpublished results to be discussed as well. Refer to Letter TT, Response 56.

SW-15. Refer to Response 10 of this letter regarding discussions of hatchery versus wild fish. With respect to the AMP, it is not the goal of the AMP, nor does SPU claim that environmental consequences can be completely prevented through its implementation. Rather, its primary purpose is to help meet mitigation goals by minimizing risks of long-term impacts. The comment omits what is potentially the most important factor in controlling impacts and that is ability to control of the number of fry released depending on the monitoring results and subsequent evaluation. Refer to Section 1.1.1 of the AMP. Also refer to Letter TT, Response 56.

SW-16. Text has been added to the AMP (Section 1.1.5) to clarify that those involved in adaptive management will consider that potential hatchery effects might have occurred during operation of the interim hatchery. The improvements incorporated in the replacement hatchery provide the opportunity to evaluate cause and effect relationships on differences between hatchery and natural origin returns reported during the operation of the interim hatchery, verify if such changes will continue with the new facilities and determine the significance of any differences. Trend analyses will utilize all applicable information available, including that collected before and during the operation of the interim hatchery. Refer to Response 14 of this letter.

SW-17. The comment addresses an issue that is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please refer to General Response No. 1.

The goals of the Cedar River sockeye hatchery differ fundamentally from many other mitigation hatcheries. Under the LMA, SPU is required to provide a facility that is capable of producing fry up to an agreed upon capacity. The potential to vary actual production levels allows adjustments to the number of fry released to be compatible with the rearing capacity of the environment and to minimize or avoid adverse effects on naturally spawning populations. This approach is consistent with hatchery reform recommendations developed by the Hatchery Science Reform Group (HSRG) to consider freshwater carrying capacity in sizing hatchery programs and to operate hatcheries within the context of their ecosystem (HSRG, 2004). The AMP has been developed to increase the chances that this program can be implemented effectively.

SW-18. The use of 10 percent of the required capacity as a worst case assumption for production could understate the potential for adverse effects and would therefore potentially mislead decision-makers. For this reason and because the basis provided for this recommendation is not derived from actual project data, SPU does not agree that such an assumption would be appropriate for worst case analysis.

SW-19. Seattle Public Utilities agrees that the replacement value for the sockeye population is generally low relative to other sockeye systems, but the comment that the interim hatchery is responsible for the low replacement rates observed in Cedar River sockeye is not consistent with the fact that low returns prompted a multiagency agreement (including: WDFW, King County, City of Seattle, Muckleshoot Tribe) for the need for the interim hatchery in 1991 to prevent further decline in the run. Lower returns began about 10 years before the first fish returned to the interim hatchery. Return per spawner rates between 1985 and 1992 showed that replacement rates were below 0.5 in 5 out of these 8 years. With only a few exceptions, return per spawner rates were above 1.0 from 1967 through 1984, and were above 2 in four of those years.

The WDFW (memo Adicks to Flint, June 2005) provided updated information on return per spawner for sockeye returning to the Cedar River. For Brood Year 1991 (the first year that the interim hatchery was operated) through Brood Year 1999 (returns through 2004), the return per spawner rate averaged 1.5, with a range of 0.3 to about 3. This analysis indicates that replacement rates have improved during the time that the interim hatchery has operated.

SW-20. Comment noted. The attachments are included in part 2 of this FSEIS.

SW-21. Refer to General Responses Nos. 2 and 3. Seattle Public Utilities has cited a wide range of literature sources in preparing the SEIS. For the worst case analysis workshop, participants were largely familiar with the general literature in their respective areas of expertise. As a result, SPU focused on providing participants with material specific to sockeye in the Cedar River and Lake Washington. The lead scientists were asked to review the lists of references and to provide additional materials where appropriate. All of these materials identified by both SPU and the participants were posted on SPU's website prior to the workshop so that they would be accessible to all participants. No effort was made to bias the panelists or the worst case analysis in the SEIS by selecting literature that supported any perspective.

Published studies and reviews on hatchery effects focus primarily on other species, in different types of culture programs, and in different locations than the program being proposed. In some cases, findings of researchers contradict those of others (for example, some researchers have found that egg size increases in hatcheries while others have found the opposite). The treatment of hatchery effects in the environmental review documents has relied on the work of others to identify potential effects of the replacement hatchery. Summaries about significant potential effects of hatcheries on naturally spawning populations are included along with recognition of uncertainty in the application of these results to the replacement hatchery. In response to this comment and others, additional information has been added to the SEIS to describe the results of representative studies done to date on hatchery effects. See Section 3.2.4.3 and Appendix C in Part 1 of this FSEIS. However, it is outside the scope of this document to include a comprehensive review of all literature on the subject.

SW-22. This example was presented to point out that a weak fry production year in the predominately 4-year cycle of sockeye had recovered to comparable production levels over two cycles after small escapement and dramatic losses of natural fry from the 1995 brood year. With the release of the report by Fresh et al. (2003), it is possible to say that the majority of fish returning in 1999 were likely to have been five-year-olds; thus these fish presumably played a more significant role in the subsequent improvement in fry production in what had been a weak production year that reoccurred every four years. Normally four-year-olds are more abundant than fives, which was the basis for the observation in the SEIS. This example has been replaced with a different analysis in Part 1 of this FSEIS Section 3.2.4.4.

SW-23. Please refer to Section 1.1.1 of the AMP for a discussion of how adaptive management is defined. As the term is being used for this project, adaptive management includes much more than monitoring alone. Important features of adaptive management include the identification of key uncertainties, linking monitoring to these uncertainties, and providing a framework for evaluating information and incorporating results into decisions. The current interim hatchery has not operated under an AMP, nor does it have the capacity for technical analyses or management adjustments that SPU expects to utilize in the proposed hatchery. Therefore, while information collected about the operation of the interim hatchery is useful, it is not necessarily applicable to the planned operation of the permanent hatchery in conjunction with an AMP. Please see Letter TT, Response 27.

Seattle Public Utilities has consulted with WDFW and is unaware of any information to support the conclusion that hatchery fry are smaller than natural fry. Seattle Public Utilities continues to collect and evaluate data related to hatchery operations and potential impacts to fish, as well as a variety of other types of information relating directly and indirectly to fish habitat in the Cedar River. Therefore, information that may appear to be "known" will likely continue to change as new data become available. It is important to also consider how differences between the interim hatchery and the replacement hatchery will affect comparisons between hatchery and natural origin sockeye. The hypotheses listed in Section 2.1.4 will guide research and monitoring efforts to continue to reduce uncertainty about the operation of the hatchery.

SW-24. The final draft of the report referenced in this comment does not include survival rate data (Fresh et al., 2003). The review of sampling procedures by Dr. John Skalski concluded that such information would be unreliable. However, since hatchery eggs and alevins are protected from mortality factors that create losses in the natural environment, higher initial losses are expected to occur to hatchery fry. The final report also concluded that run timing does not differ between hatchery and natural origin returns.

The final report by Fresh et al. (2003) did conclude that, in most comparisons, the size of female sockeye originating from the hatchery were smaller than those

produced naturally. They also conclude that the reason for some differences is not known; therefore, it is uncertain whether such size differences will continue to occur with the replacement hatchery. The general literature is not in agreement with the view expressed here that reduction in female size is an inevitable consequence of hatchery operations.

See Response 23 in this letter concerning the absence of data showing differences in fry size.

Further discussion has been added to the SEIS; in Section 3.2.4.3 and Appendix C in part 1 of this FSEIS. Also refer to Letter TT, Response 29.

SW-25. The final report (Fresh et al. 2003) concluded that the return timing of hatchery and natural origin fish do not differ. The collection of broodstock by WDFW currently includes both the early and middle part of the run. Seattle Public Utilities plans to build new broodstock facilities to better match broodstock timing with overall run timing, and to avoid shifts in run timing. Please see discussion in the HCP EA/EIS, p.4.4-20, which states that the broodstock collection facility will be designed to capture a representative subset of a target population; this is also a stated goal in the HCP on pp. 4.3-13,15 and 16.

SW-26. The difficulty in making comparisons between survival rates of hatchery and natural origin fry is discussed in Section 2.1.1 of the AMP and Section 2.4 of the FEIS. Fitness is determined by the number of fish that return to spawn and their productivity. This will be assessed as discussed in Section 2.2 of the AMP.

Assessment metrics will undergo further evaluation by the AMP committees before the AMP is implemented, and your comments will be shared with the committees.

Refer to Responses 23 and 24 in this letter.

SW-27. Refer to the discussion of the interim hatchery Section 1.1.5 of the AMP concerning the establishment of baseline information. Also refer to Letter TT, Response 56 and to Response 16 of this letter. The current interim hatchery has not operated under an AMP, nor does the interim hatchery have the capacity for management adjustments that SPU will use in the proposed hatchery. The replacement hatchery program will substantially differ from the interim hatchery program, operating under a new set of protocols, and new parameters will be measured. Additional language has been added to the AMP, Section 1.1.5, concerning the establishment of baseline information relative to the interim hatchery operations.

SW-28. SPU is not aware of any effort to suppress the Fresh, et al.(2003) report.

Once the Adaptive Management Plan is implemented, new information will be incorporated into the City's hatchery management program. Seattle Public Utilities continues to facilitate the collection and evaluation of data related to hatchery

operations and potential impacts to fish, as well as a variety of other types of information relating directly and indirectly to fish habitat in the Cedar River. The City has released published data related to the interim hatchery project as it has become available, and it has incorporated these data into the decision-making process. Refer to General Response No. 2. Identifying uncertainties is not an attempt on the part of SPU to downplay the importance of these issues, but to acknowledge and disclose the areas of uncertainty for decision-makers. In accordance with SMC 25.05.080, these areas of uncertainty have been identified, the potential likelihood of occurrence has been estimated, and the potential worst case outcomes have been described.

Please note, that for purposes of worst case analysis, no AMP was assumed.

SW-29. Analysis of adult-to-adult production for hatchery and wild groups coupled with trends in fry per spawner and egg to adult returns would provide basis for determining if reproductive fitness is declining over time. Under the proposed structure for the AMP, all questions and assumptions will be subject to ongoing review by the Technical Work Group, the Independent Science Advisers and the interested public. A central premise of the AMP is the ability to improve on hatchery operations over time in response to new information. Alternatively, the level of production can be altered to reduce or eliminate impacts. Refer to Response 26 of this letter.

The comment regarding diversions of funds to other mitigation measures presents a policy issue that is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner.

The process of designing monitoring studies, evaluating results and making decisions is not controlled by SPU; rather, it is a shared responsibility of NOAA Fisheries, USFWS, and WDFW and the City of Seattle.

SW-30. The workshop format invited questions and discussion among the invited scientists and was not structured to be biased. While other interested parties were allowed to observe, the workshop was structured within a limited time, and only workshop participants were allowed to actively participate in the discussion. Refer to General Response No. 3.

SW-31. Refer to General Response No. 3. The report containing information about size difference (see Response 24 of this letter) was contained in a draft report and was undergoing further revisions by WDFW at the time of the workshop. Nevertheless, two of the authors and others familiar with the draft report were in attendance at the workshop. The study was not intended to assess hatchery effects on fitness and the authors do not conclude that the hatchery has been responsible for reducing fitness.

No effort was made to bias the panelists by selecting literature that supported any perspective, and there was no effort to withhold information.

Age data for Chinook in the Cedar River is included in the Burton et al. (2003) report, and this report was available to workshop participants. Since the worst case analysis workshop, another annual report that includes Chinook carcass age data for 2001-2003 has been published (Burton et al., 2004). The percentage of 3-year-old Chinook females found in the Cedar River for 2001, 2002 and 2003, respectively, were 29 percent, 3 percent, and 8 percent. Information is complete for the 1998 brood year only; the proportion of 3, 4 and 5-year-old females was 16 percent, 70 percent and 14 percent, respectively, for that year. See also Response 12 of this letter.

Scientists on the worst case analysis panel on superimposition were provided data on Chinook and sockeye size at age by sex for years 2001-2003 and predicted nest depths for sockeye of various lengths. The panel was also given a copy of a table summarizing data from a comprehensive summary on spawning depths of salmonids and proposed burial depth criteria from DeVries (1997).

SW-32. Please refer to General Response No. 3 and Appendix C of the SEIS. Refer to Response 31 of this letter for a discussion of information provided to workshop participants. See also Response 23 of this letter regarding fry size.

SW-33. Refer to Response 13 of this letter.

SW-34. Comment noted. Any quantification from the workshop was acknowledged to represent best professional judgment in the absence of definitive data.

The remaining comments submitted by the commenter were included in attachments and were not part of this official SEIS comment letter. 'Comment noted' applies to all remaining comments.

Vikki Anselmo - Cedar River Hatchery Proposal Page 1

From: Thomas Buehrens <tbuehren@bowdoin.edu>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/13/2005 2:30:20 PM
Subject: Cedar River Hatchery Proposal

Ms. Anselmo-

1 I wasn't able to attend the meeting, so I wanted to drop you a quick note about the proposed permanent hatchery facility on the Cedar River. I am opposed to this hatchery. While I enjoy the fishery on the lake, when it occurs, I feel that a hatchery is not only a bad investment, but ecologically irresponsible. There is a considerable body of scientific evidence as I am sure you are aware, that suggests that most, if not all of the run of Cedar River Sockeye are an introduced stock (Baker River fish). By putting in a hatchery, we

2 will not only have more non-native fish, but more non-wild fish. There is also a considerable body of scientific research that suggests the negative impacts introduced and hatchery-origin fish can have on wild fish populations. The Cedar River is home to populations of both ESA threatened Chinook Salmon, as well as a winter steelhead run that is chronically depressed, and has failed to meet escapement for several years. Putting in a hatchery facility

3 will be costly, and may pose greater risks to already depressed runs of fish. I feel that the money would be better spent in other areas such as chinook and steelhead recovery efforts. The Cedar already produces hundreds of thousands of sockeye for fishermen. As one fishermen, I am content with the current number of fish and don't feel that a new hatchery is justifiable. Thank you for your time and consideration of my viewpoint.

Sincerely,
Thomas Buehrens

Responses to Comment Letter TB (Thomas Buehrens)

TB-1. Comment noted. The potential for environmental/ecological impacts is disclosed in the FEIS, and in the FSEIS. The commenter is correct that most scientists agree that the current sockeye population is an introduced population. Refer to Section 2.4.2 of the FEIS for a discussion of the origins of Cedar River sockeye.

TB-2. Comment noted. Section 2.4.2 of the FEIS discusses the status of steelhead, as well as escapement trends for the last several years. Both Section 2.4.3 of the FEIS and components of the worst case analysis in the SEIS discuss potential impacts to wild fish, including Chinook, from hatchery construction and operation.

TB-3. Comment noted. There is considerable scientific discussion and debate about the effects of hatcheries. For the discussion of potential effects of this hatchery, please refer to Letter TT, Response 23, Section 2.4 of the FEIS and Section 4.6 of the HCP. The worst case analyses required by the Hearing Examiner also discuss various potential impacts that increasing the hatchery production may have on wild-spawned sockeye and on Chinook. Please see Chapter 3 of the SEIS.

Vikki Anselmo

From: Swampdog <swampdog@olypen.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/21/2005 9:27:20 PM

1 Dear Ms. Anselmo. I am writting to you to express my oposition to the proposed sockeye hatchery on the Cedar River. Hatcheries can not solve the problem of declining fish runs. Hundreds of hatcheries have been built over the last 70 years and yet salmon run have continued to decline. History and sciece have proven that only habitat protection and restoration can maintain salmon runs.The proposed hatchery will not build up fish runs but will rather threaten the health of the Cedar River's wild runs. This hatchery has the potential to decrease fish populations. Thank you. Coleman Byrnes.

Responses to Comment Letter CB (Coleman Byrnes)

CB-1. Comment noted. Impacts of the proposed hatchery on wild fish runs are disclosed in the FEIS and the SEIS. See Letter TT, Response 23 for a discussion of the scientific debate around the potentially inherent impacts of hatcheries.

From: <CaptDarlin@aol.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/21/2005 1:26:34 AM
Subject: Comment to Cedar River Sockeye Hatchery SEIS

Dear Ms. Anselmo:

I am writing to comment on the SEIS relating to the proposed Cedar River Sockeye Hatchery.

1 I am--and have been--opposed to this project by the city. It is extremely costly. It is my understanding that the city's budget is tight. Therefore, it makes no sense for the city to waste so much money on such a misbegotten project as the hatchery. Everyone knows (because it's very well publicized in scientific journals) that hatchery fish are genetically inferior fish. However, in this case, that's only half the story: these fish will very likely superimpose over the critical habitat of the wild Chinook salmon in the Cedar River and Puget Sound. This superimposition will likely eliminate our cherished wild runs of these fish.

2 I realize that Mr. Bush believes that farmed fish are just as good as wild fish. It distresses me greatly, however, for my (usually) progressive City to take on this unfounded opinion. We must do everything we can to preserve the wild Chinook runs--and that is not to build a hatchery. Instead, the city should put that money to habitat restoration so that the wild (genetically diverse) Chinook will have a fighting chance at survival.

3 I am completely opposed to this hatchery--and everyone I know shares that opinion. Unfortunately, I learned only this weekend that you were accepting comments on the SEIS. Therefore, please accept this comment in opposition to wasting any more money on this terrible idea. Let's cut our losses and put what money is left into the wild salmon that are fighting to survive in the Cedar River and Puget Sound.

Responses to Comment Letter CD (CaptDarlin@aol.com)

CD-1. Comment noted. Please see Letter TT, Response 23 and Appendix C of the FSEIS for a discussion of hatchery effects. Genetic impacts are discussed in Section 3.2 of the SEIS, while superimposition impacts are discussed in Section 3.6 of the SEIS. For further information on these topics and other potential adverse effects on Chinook, see the FEIS, Section 2.4.

CD-2. The City of Seattle is an active partner in WRIA 8's Chinook recovery planning. The City has made, and will continue to make, investments in habitat in the Cedar River. Refer to General Response No. 6 for a discussion of SPU's involvement in the WRIA 8 Salmon Conservation Plan. The decision of whether to build and operate a sockeye hatchery is a joint decision by NOAA Fisheries, USFWS, WDFW, and the City of Seattle.

CD-3. Comment noted. This comment addresses the policy question of whether or not to construct the hatchery. While it is an appropriate question to be addressed by decision-makers, it is not directly related to either the Worst Case Analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. See General Response No. 1.

From: "Talibah Chiku" <tchiku@iglide.net>
To: "Vikki Anselmo" <vikki.anselmo@Seattle.Gov>
Date: 3/21/2005 8:45:13 AM
Subject: Re: Take my vote

1 A hatchery is a bad plan since it will kill the Chinook. But in general my statement is applicable to any any all efforts to intervene in Native culture, ideas, plans and development.

—— Original Message ——
From: Vikki Anselmo <vikki.anselmo@Seattle.Gov>
To: <tchiku@iglide.net>
Sent: Monday, March 21, 2005 8:01 AM
Subject: Re: Take my vote

> What specific issue is this comment in regard to?
>
> Vikki Anselmo
> Seattle Public Utilities
> Director's Office
> (206) 684-5851 Main
> (206) 386-4560 Direct
>
> >>> "Talibah Chiku" <tchiku@iglide.net> 3/20/2005 4:42:17 PM >>>
> I don't know all the studies that actually become sophisticated
> stone-walling attempts to justify what the regional, state, national
> municipalities want to do to endanger Native peoples and all that has
> been part of their culture and nation.
>
> No, absolutely no to any changes that impact Native needs – fish,
> wildlife, lands, culture and livelihood, even including slot machines.
>
> Thank you.
>
>
> –
> No virus found in this incoming message.
> Checked by AVG Anti-Virus.
> Version: 7.0.308 / Virus Database: 266.7.4 - Release Date: 3/18/05
>
>

Responses to Comment Letter TC (Talibah Chiku)

TC-1. Comment noted. Potential impacts to Chinook are discussed in Section 2.4 of the FEIS, and in Chapter 3 of the SEIS.

Vikki Anselmo - Official comment to the Cedar River Sockeye Hatchery SEIS Page 1

From: Victor Garcia <guemesgarcia@earthlink.net>
To: <vikki.anselmo@seattle.gov>
Date: 3/21/2005 10:43:27 PM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

Vikki Anselmo
Seattle Public Utilities
700 5th Avenue, Suite 4900
P.O. Box 34018
Seattle, WA 98124-4018

Ms. Anselmo,

1 I am very concerned about the proposed sockeye hatchery onthe Cedar river for the following reasons:

* Hatcheries produce a behaviorally less fit, genetically non-native run of salmon.

2 * The fatter hatchery fish negatively compete with the wild fish.

3 * Diseases carried by the overcrowded hatchery fish might negatively affect Chinook recovery on the Cedar River and in Puget Sound.

4 I really don't want to see an experiemnt onthe CEdar that would negatively affect the wild sockeye stocks or adversely impact the other local runs.

Victor Garcia

Responses to Comment Letter VG (Victor Garcia)

VG-1. Comment noted. Please see Letter TT, Response 23 for a discussion of the current science about the potential inherent hatchery effects, including effects on fitness. Potential impacts to genetic fitness and genetic diversity are disclosed in Section 3.2 of the SEIS. See also Appendix C in the FSEIS.

VG-2. Comment noted. Section 3.4 of the SEIS discusses the potential for competition for food supply between the proposed increase in sockeye and other Cedar River salmonids. Please note that unlike most hatchery programs, the sockeye juveniles will be released soon after they are ready to leave the incubators; consequently size differences are minimized between hatchery and naturally produced sockeye fry.

VG-3. Comment noted. The commenter raises an issue outside the scope of the SEIS. Please see General Response No. 1. Risks of disease outbreaks were discussed in Section 2.4.3 of the FEIS.

VG-4. Comment noted.

From: Roz Glasser <rozglasser@juno.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/14/2005 10:45:35 PM
Subject: Cedar River Sockeye Hatchery SEIS Public Meeting

Vikki,

1 I did not want the fact that I was not at the SEIS public meeting last week to be misinterpreted as a lack of interest or concern for the hatchery project. My complete comments will be submitted by the end of the comment period.

2 One reason I did not attend was that I did not care to be subjected to the intimidation tactics that leading hatchery proponents, and memebers of the AFC, are using to malign my reputation and persuade the recreation fishing community into supporting this project. Specifically, in the January 2005 edition of The Reel News, Chuck Wishman and Frank Urabeck, authored an article (Last Chance To Save Lake Washington Sockeye?) that referred to me as an "extremist" who opposes the hatchery "mainly on philosophical grounds". I see nothing extreme about attempting to bring the best available science into the discussion of whether SPU rate payers should pay millions of dollars for an dubious experiment that numerous independent studies have shown will not succeed, when other more viable alternatives that can actually improve salmon stocks in the Cedar River, are available.

3 Nor are my concerns, or those of the scientists involved, philosophical in nature. Our objections are supported by this same independent science. By contrast, the authors go on to mislead the reader by stating that "...the hatchery fish are comparable with other fish populations." The final Otolith Report (Evaluation Of The Cedar River Sockeye Salmon Hatchery: Analyses Of Adult Otolith Recoveries, January 2003) concludes that the average length of 16 out of 31 natural-origin sockeye adults was greater than the sockeye from the interim hatchery. It further finds that natural origin female sockeye were larger than females of the same age from this hatchery. Thus, sockeye from the Cedar River hatchery are not comparable, as they are required to be, and no amount of stating to the contrary will make it so.

4 I have been involved with many public processes having controversial natural resource issues, but never have I observed the level of vitriol against the opposition that I see in this process. I can only attribute it to the inherent bias of the City and its advisors toward the hatchery and an almost complete exclusion of independent science in analyzing its affects and likelihood of success.

5 Please include these comments in the official record of comments on this project.

Thank you,
Roz Glasser
"The things that will destroy us are: politics without principle; pleasure without conscience; wealth without work; knowledge without character; business without morality; science without humanity; and worship without sacrifice."
-Mahatma Gandhi (1869-1948)

CC: <louploup@louploup.net>, <rozglasser@juno.com>

From: Vikki Anselmo
To: "rozglasser@juno.com".SEAGOV1.RES04
Date: 3/17/2005 7:55:12 AM
Subject: Re: Cedar River Sockeye Hatchery SEIS Public Meeting

I received your email and, as you requested, it will be included and considered among the comments we receive on the draft SEIS.

Vikki Anselmo
Seattle Public Utilities
Director's Office
(206) 684-5851 Main
(206) 386-4560 Direct

>>> Roz Glasser <rozglasser@juno.com> 3/14/2005 10:39:27 PM >>>
Vikki,

I did not want the fact that I was not at the SEIS public meeting last week to be misinterpreted as a lack of interest or concern for the hatchery project. My complete comments will be submitted by the end of the comment period.

One reason I did not attend was that I did not care to be subjected to the intimidation tactics that leading hatchery proponents, and memebers of the AFC, are using to malign my reputation and persuade the recreation fishing community into supporting this project. Specifically, in the January 2005 edition of The Reel News, Chuck Wishman and Frank Urabeck, authored an article (Last Chance To Save Lake Washington Sockeye?) that referred to me as an "extremist" who opposes the hatchery "mainly on philosophical grounds". I see nothing extreme about attempting to bring the best available science into the discussion of whether SPU rate payers should pay millions of dollars for an dubious experiment that numerous independent studies have shown will not succeed, when other more viable alternatives that can actually improve salmon stocks in the Cedar River, are available.

Nor are my concerns, or those of the scientists involved, philosophical in nature. Our objections are supported by this same independent science. By contrast, the authors go on to mislead the reader by stating that "...the hatchery fish are comparable with other fish populations." The final Otolith Report (Evaluation Of The Cedar River Sockeye Salmon Hatchery: Analyses Of Adult Otolith Recoveries, January 2003) concludes that the average length of 16 out of 31 natural-origin sockeye adults was greater than the sockeye from the interim hatchery. It further finds that natural origin female sockeye were larger than females of the same age from this hatchery. Thus, sockeye from the Cedar River hatchery are not comparable, as they are required to be, and no amount of stating to the contrary will make it so.

I have been involved with many public processes having controversial natural resource issues, but never have I observed the level of vitriol against the opposition that I see in this process. I can only attribute it to the inherent bias of the City and its advisors toward the hatchery and an almost complete exclusion of independent science in analyzing its affects and likelihood of success.

Please include these comments in the official record of comments on this project.

Thank you,
Roz Glasser
"The things that will destroy us are: politics without principle; pleasure without conscience; wealth without work; knowledge without character; business without morality; science without humanity; and worship without sacrifice."
-Mahatma Gandhi (1869-1948)

Vikki Anselmo - Re: Cedar River Sockeye Hatchery SEIS Public Meeting Page 1

From: "rozglasser@juno.com" <rozglasser@juno.com>
To: <vikki.anselmo@Seattle.Gov>
Date: 3/17/2005 6:32:01 PM
Subject: Re: Cedar River Sockeye Hatchery SEIS Public Meeting

Thanks Vikki

Responses to Comment Letter RG (Roz Glasser)

RG-1. Comment noted.

RG-2. Comment noted.

RG-3. Seattle Public Utilities is unable to find the quoted phrase in the DSEIS. The issue of whether or not there are inherent hatchery effects and the extent and nature of those effects is an issue undergoing much scientific debate. Refer to Letter TT, Response 23, and to Appendix C, which has been added to Part 1 of this FSEIS.

RG-4. Comment noted.

RG-5. Your comments have been included in this FSEIS.

Vikki Anselmo - Official comment to the Cedar River Sockeye Hatchery SEIS Page 1

From: "John Lombard" <jlombard2415@earthlink.net>
To: <vikki.anselmo@seattle.gov>
Date: 3/21/2005 9:19:19 AM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

Dear Ms. Anselmo,

1 As one who has followed the controversy over the City of Seattle's existing and proposed sockeye hatchery on the Cedar River for many years (I was Watershed Coordinator for the Greater Lake Washington watershed from 1996 to 2000), I was very disappointed to see that the Draft SEIS for the hatchery does not report on what has actually been learned from more than 10 years of study regarding the fitness of hatchery sockeye--particularly regarding their return rates, in comparison to wild sockeye. This is obviously the key statistic for the success of the hatchery, and it is the key statistic regarding the effect of the hatchery on the genetic fitness of sockeye in the river. Moreover, since sockeye returns the last couple of years for Bear Creek and the Cedar River were both down dramatically from estimates at the Locks (150,000 less than predicted in 2004), SOMETHING seems to be seriously going awry for the fish. While it is unlikely this is primarily due to the hatchery, if hatchery returns have been consistently lower than wild returns (as is my understanding), problems with hatchery fish could be aggravating an already very problematic situation.

2 Page 2-9 asks the right questions about the effect of the hatchery on reproductive fitness of Cedar River sockeye. Unfortunately, since the DSEIS provides no information regarding what is (or should be) already known on these issues, and how the City has responded, my faith in the Adaptive Management program the City proposes for the hatchery is undermined. As the saying goes, actions speak louder than words. The Final SEIS should describe how operations of the hatchery have changed, if at all, in response to the knowledge gained from the last 10 years.

Thank you for the opportunity to comment.

John Lombard
Sustainable Fisheries Foundation/
Steward and Associates
Home Office: (206) 524-2944

Responses to Comment Letter JL (John Lombard)

JL-1. The SEIS is narrowly focused on the issues that the Hearing Examiner directed must be addressed. Learning from the Lake Washington Studies and other scientific work of the last 10 to15 years was used where appropriate, and scientists involved in the studies were consulted. Refer to General Response No. 2.

Return rates are affected by many factors in addition to fitness, and can be calculated in different ways. Hatchery programs generally produce higher adult-to-adult return rates than those resulting from natural spawning due primarily to survival advantages during incubation. There is no evidence to suggest that this is not the case for the Cedar River sockeye. See Section 2.1.1 of the AMP and p. 2.4-34 of the FEIS for a discussion of fry to adult survival rate comparisons. The discrepancy between estimated sockeye movement past the locks and the estimates of spawning sockeye in Lake Washington tributaries is a topic of University of Washington research and analysis by fishery co-managers.

JL-2. See General Response No.1 and 2 of this letter regarding the scope of the SEIS and data used in developing this FSEIS. Also refer to Letter TT, Responses 29 and 56. See also Appendix C of the FSEIS.

From: "Muller, Nancy" <nmuller@path.org>
To: <vikki.anselmo@seattle.gov>
Date: 3/21/2005 9:33:01 AM
Subject: FW: Official comment to the Cedar River Sockeye Hatchery SEIS

Dear Ms. Anselmo:

1 I would like to comment on the Cedar River Sockeye Hatchery issue. I am opposed to the hatchery because it jeopardizes the native salmon in favor of catering to the sports fishing people. Studies have been done pointing out the flaws of the Cedar River having sockeye introduced and eventually choking out the Chinooks - the money for this project needs to be spent on something else that is of higher priority. Tell the sport fisher people that the city has studied the impact the hatchery will have on an existing salmon population and there are too many negative outcomes to approve it.

Thank you.

Nancy Muller
mulloyd@juno.com

Responses to Comment Letter NM (Nancy Muller)

NM-1. Comment noted. The project's potentially significant adverse effects on Chinook are discussed in detail in the SEIS, FEIS, HCP and HCP EA/EIS.

This comment addresses the policy question of whether or not to construct the hatchery. While that is an appropriate question to be addressed by decision-makers, it is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Refer to General Response No. 1 for a discussion of the scope of the SEIS.

Vikki Anselmo - Official Comments to the Cedar River Sockeye SEIS

From: "sue Nattinger" <snattinger@hotmail.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/21/2005 11:49:10 PM
Subject: Official Comments to the Cedar River Sockeye SEIS

2005
Subject: Official Comments to the Cedar River Sockeye SEIS
To: vikki.anselmo@seattle.gov

Dear Ms. Anselmo,

1 I am writing to express my concern about the proposed Cedar River sockeye hatchery. The draft SEIS is flawed because it fails to accurately portray risk.

2 I prefer to see money spent on habitat, which the Cedar needs more than a hatchery that's not likely to work.

Sincerely,

Sue Nattinger

Responses to Comment Letter SN (Sue Nattinger)

SN-1. Refer to Letter TT, Response 4 for a discussion of how risk and uncertainties have been addressed in the SEIS.

SN-2. Comment noted. This comment addresses the policy question of whether or not to construct the hatchery. While that is an appropriate question to be addressed by decision-makers, it is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Refer to General Response No. 1 for a discussion of the scope of the SEIS.

Refer to General Response No. 6 for a discussion of the City's investments in habitat enhancement and restoration efforts.

Vikki Anselmo - Official comment to the Cedar River Sockeye Hatchery SEIS Page 1

From: Gail Moore Nicolls <guernesgail@cablerocket.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/21/2005 4:14:27 PM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

1 Please do not even consider going ahead with the Cedar River Sockeye Hatchery in view of the inevitable contamination of the native species with a nonnative species. It is impossible to know how the native species would be effected. Therefore it makes no sense to go ahead with this nonessential project which could have irreversible negative effects.

Thank you for your attention to my comments.

Gail Nicolls
7802 West Shore Drive
Anacortes, WA 98221

Responses to Comment Letter GN (Gail Nicolls)

GN-1. Comment noted. Potential impacts to native salmonids are discussed in the FEIS Section 2.4 and in the SEIS. See in particular Chapter 3 of the SEIS.

From: "Martin Norris" <martian1@verizon.net>
To: <vikki.anselmo@seattle.gov>
Date: 3/20/2005 4:39:59 PM
Subject: No on the Cedar River Sockeye Hatchery

Dear Ms. Anselmo:

1 I wish to comment on the Cedar River Sockeye Hatchery issue. I'm against the hatchery because it puts the native salmon at risk. Instead of paying attention to the needs of the salmon that are already there, the hatchery plan caters to the sports fishing people. I like to fish - I like going out on charters and fishing for cod and snapper, but I don't see anyone pushing to open a hatchery that would replace them! The studies have been done pointing out the flaws of the Cedar River having sockeye introduced and eventually choking out the Chinooks - the money for this project needs to be spent on something else that is of higher priority. Tell the sport fisher people that the city has studied the impact the hatchery will have on an existing salmon population and there are too many negative outcomes to approve it.

Thank you.

Martin Norris

Responses to Comment Letter MN (Martin Norris)

MN-1. Comment noted. Potential impacts to Chinook and sockeye are discussed in the FEIS Section 2.4 and in the SEIS. See particularly Chapter 3 of the SEIS.

From: "Rachel Norris" <norrisrl@verizon.net>
To: <vikki.anselmo@seattle.gov>
Date: 3/20/2005 1:17:18 PM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

Dear Ms. Anselmo:

1 I wish to comment on the Cedar River Sockeye Hatchery issue. I'm against the hatchery because it puts the native salmon at risk. Instead of paying attention to the needs of the salmon that are already there, the hatchery plan caters to the sports fishing people. I like to fish - I like going out on charters and fishing for cod and snapper, but I don't see anyone pushing to open a hatchery that would replace them! The studies have been done pointing out the flaws of the Cedar River having sockeye introduced and eventually choking out the Chinooks - the money for this project needs to be spent on something else that is of higher priority. Tell the sport fisher people that the city has studied the impact the hatchery will have on an existing salmon population and there are too many negative outcomes to approve it.

Thank you.

Rachel Norris
norrisrl@verizon.net

Responses to Comment Letter RN (Rachel Norris)

RN-1. Comment noted. Potential impacts to Chinook are disclosed in the FEIS, Section 2.4 and in the SEIS. See particularly Chapter 3 of the SEIS.

Paul R. Olson
6917 NE 204th
Kenmore, WA 98028
March 16, 2005

Vikki Anselmo
Seattle Public Utilities
700 5th Ave. Suite 4900
PO Box 34018
Seattle, WA 98124-4018

RE: "Official comment to the Cedar River Sockeye Hatchery SEIS."

To the Powers that Be:

1 I appreciated the good discussion presented in the DSEIS and the so called "worst case" scenario however I feel a few key points were overlooked that need to be addressed. In the AMP on page 1-7 I'll quote, "In the adaptive management process, high priority is placed on learning about the subject ecosystem." That is a powerful statement and I hope it can be lived up to.

2 I'll start with the apparent focus that the genetic origin of the Lake Washington watershed sockeye salmon originated from Baker lake WA. I thought there had been previous DNA work analysis that also studied the possible origin of the stock out of the Fraser river system in BC. Please do not overlook the fact that in the late 1930's and early 40's a number of the profs from the School of Fisheries sought summer employment studying the sockeye races of the Fraser river by employment with the International Pacific Salmon Commission. Profs Lauren R Donaldson, Arthur D Welander, and Milo Bell worked actively in those areas and often referred to their sockeye experiences in their lectures. At that same time it was common for sockeye eggs to be incubated in the UW hatchery, and these eggs often came from Cultus lake stock or Harrison lake stock. They were usually reared for a short time in feeding experiments and planted to lake Washington. In the early summer of 1949 I recall, tempering and planting Cultus lake sockeye into the ship canal off the crew house. With limited rearing area they were overcrowding the rearing tanks and it was best to release them, that batch probably numbered 4 to 5000 juveniles.

3 Beach spawning by sockeye are referred to in many places but the north end of the lake spawners are never mentioned. Granted the shallow water spawners off Pleasant Point are much more obvious but speak to the Muckleshoot fisherman about the north end lake spawners. While fishing the excess Coho returning to the Issaquah hatchery they reported 50% of their catch was black sockeye good for nothing which WDF required them to report in their sockeye catch so they discontinued the north end Coho fishery.
The north end strong presence of sockeye should not be ignored and the spring water they spawn in will be addressed shortly below.

4 One aspect of salmonid homing was never mentioned in all sections of the report; that is the roll of the olfactory senses in guiding the fish back to its' area of origin, I realize it is generally understood but to date not clearly diagnosed. Years ago perhaps late 1960's, two U of W profs, Alan C DeLacy and Paul Fields played with an encephalograph attached to the brain lobes of adult homing salmon mounted in a laboratory situation where the fish was alive and aspirated in the gills with flowing water but with the nasal passages open for introducing varied source

4 waters. The recorded brain wave action measured the fishes response to the different waters. I am not aware of it being ever published, perhaps in the Research in Fisheries, published by the College, but results were impressive. "Home" water generated maximum brain reaction, refrigerated home water still generated response after about a week, water with spawning fish above generated some brain response, boiled home water cooled, offered no response, as also did distilled water. Work was very preliminary but interesting.

5 My intent is to point out the distinctive water types that the fish are returning to, that in your text discussions simply seem to be described as all quite similar. You comment that by planting the hatchery fry in various locations along the river you expect to randomize the hatchery brood returning to the river in general, assuming the one or two days or actual only hours of orientation in the river will orient them back to that spot? You ignore the three month incubation in the hatchery water as being apparently very incidental in registering the "home" distinction in the brain of these creatures. I suggest perhaps this is when the "home" characteristics are established in the short term spawning site reference of the sockeye. And the hatchery site fish in seeking their home were the hundreds reported trying to move upstream on the new fish ladder above Landsburg on page 3-16 of the DSEIS. I puzzle because they are referred to as natural-origin sockeye and I doubt very strongly if you sacrificed them to remove the otolith to determine if they were natural or hatchery marked otolith? Because the hatchery site receives its water largely from springs and sources upstream of Landsburg dam the fish were perhaps homing on the strongest smell which was upriver.

6 Working on the Cedar river within the watershed was an eye opening experience in the fall of 1987. It had been an extremely dry summer and fall, Rattlesnake lake at Cedar Falls had decreased from 110+ acres to a small pond less than four acres. A similar change occurred in Oct of 1952 when it decreased to 10 acres. During this time the coffer dam at Chet Mo was being rebuilt and penstock flow was shut off for 69 days. No pumps had yet been installed in Chester Morse lake upstream, and the typical leaky glacial moraine downstream of Chester Morse was very dry. River water at Cedar Falls (RM 33.5) was puddled and not flowing, the river below the 50 road bridge was dry for a distance in excess of 3 miles, this would be RM 30 to 33.3 on the Cedar river. It began flowing again just upstream of Taylor creek from subsurface seepage. Geology studies in the Rattlesnake lake area indicated very large river boulders buried at 200 feet with flowing water which was explained as the Wilderness river location active toward the end of the glaciation period, coming out of the Snoqualmie basin, flowing to the south across Taylor creek area beyond the Green river, toward Olympia and exiting to the ocean in the grays Harbor area. What I am attempting to point out is a lot of different source water enters the Cedar river above Landsburg that come out of different areas of geology and each of these systems could have a distinctive odor characteristic. The upper shed Cedar river, Hobo, Coon, Steele, Williams, Taylor, Rock and an unnamed creek entering the Cedar from the south just above Landsburg all contribute their bit. Forest soil research indicate in late summer early fall the soil colloids released into the creek systems increase significantly and likely represent different odors, these same products become a problem in water treatment process because when treated with chlorine they form THM's which are considered carcinogenic.

7 In numerous places throughout the report the question of straying arises. I feel due to the dominating olfactory control in homing this typically is not a significant problem. But water source and treatment if necessary for the proposed hatchery could influence the homing tendencies to that location. The spring water entering the lake in the Pleasant Point area that facilitates the beach spawners is probably quite different from Cedar river water, it would be informative to know of well water interception in the hillside east of the beach. Moving north to

7 the north end lake spawners I suggest their spawning area is strongly influenced by the aquifer underlying the Swamp creek/Kenmore area to the north, which continues with flowing springs in Snohomish county and some geologists suggest might originate as far north as the Sultan river basin. Living 50+ years in this basin I've been intrigued by the underlying aquifer. A recent Metro 6' diameter sewer project buried 45 feet deep in 73rd Ave NE encountered numerous water zones and required very extensive pumping to dewater. One 6" drill hole to 45' had water actively discharged 10 feet above ground surface. I believe it is this same zone that extends into the north end of Lake Washington and supplies the north end sockeye spawning area.

8 Moving eastward in the WRIA 8 area one encounters North creek with tributaries Canyon and Penny creek which is also supplied along their length from the north with numerous springs. A similar story going further east to Little Bear creek. Again further east to Bear creek with tributaries Cottage Lake creek and Daniels creek all coming in from the north. Evans creek also a tributary to Bear creek but coming into it from the east would likely have a different source and odor. Then swinging further south to the Issaquah creek system with the North fork, the East fork and the main stem, all arising out of a distinctly different landscape. Seeing adult spawning salmon jump for the exit pipe on some of the Issaquah hatchery ponds makes one wonder what is controlling these fish? Do each of these systems have a distinct odor or finger print that the fish can identify? This is why I would find it unlikely to find fish straying from the Cedar river into the Bear creek system. Systems physically well separated and representing different water origins, soil and landscape types. Other animals distinguish their offspring for nursing by smell from a vast herd of similar appearing offspring, shouldn't we understand perhaps a similar ability in fish, even though as humans we seem to have lost a lot of the olfactory ability?

9 In the discussion of the Worst Case Analysis –Predation lists a table on page 5. No mention is made of in gravel predation to the egg or yolk sac fry and I feel this could be significant. I suggested in comments to the DEIS that Hydra could play a significant part in mortality and that was brushed off. I suggest, placing a yolk sac fry in a petri dish with Hydra and watch the fry spin in pain when hit by the nematocysts of the hydra. The fry appear to survive but if held through yolk absorption they die at that stage similar to other fish diseases such as "white spot". Documentation by Jim Ames (WDF) on sockeye through the years seemed to indicate the heavy egg and fry loss during excessive periods of freshet or flood. However the brood year following the high flows had unusually high egg survival and I suggest it is much more than just silt removal from the gravel, I suggest it is a marked reduction in hydra. Weaver creek sockeye spawning channel in British Columbia had to initiate special treatment to reduce the hydra infestation. Inspection of the dead salmon carcasses along the Cedar river often reveal numerous hydra attachments. I believe a similar population exists subsurface in the gravel.

10 On page 1-17 of the DSEIS it states the hatchery is not likely to change the abundance of predators. I question this statement from the perspective of the abundance of hydra and perhaps other predators and available food for them. Processing 34 million eggs requires something like 8000 females and an equivalent number of males result in 16,000 carcasses being released back into the river which could total 80,000 pounds of fish carcass. Granted with respect to the total carcass load in the river it is probably less than 50 % of total but it could be significant. Is there another way to return the nutrient to the system but yet reduce the load in the river? John R Donaldson in the late 50's working as aquatic chemist for WDG did repeated annual experiments on Loma lake in Snohomish county with the introduction of crab waste from a hatchery tank truck and grinding pump into the lake. This nutrient addition significantly boosted the zooplankton production with negligible algal response, increased the epilimnion depth in the lake and increased catchable trout in the lake. Might such an addition of ground up fish carcasses by

10 boat be distributed in the lake to stimulate the zooplankton population as the early sockeye fry arrive in the lake? Rather than have the nutrients wash out of the river midwinter on to the delta of the river or deeper levels of the lake, place them high in the water column at the time of year most beneficial to the zooplankton. Or would such a program backfire by increasing the infection of IHN virus throughout the ecosystem of the lake? Challenging questions all related to the ecosystem. As the program presently exists I suspect with the build up of carcass debris near the mouth of the river it would naturally attract crayfish and amphipods which in turn would attract predator fish in search of food. Enduring the cold temperatures I would expect this predator population to remain until the sockeye fry start emerging from the river and from the beach spawning areas.

11 On page 2-7 of the AMP you discuss presmolt surveys which have been conducted quite successfully for many years and used in the forecast estimate of returning runs. You mention the complication of analysis due to the mix of natural populations. You mention Bear creek and its contribution but do we really know whether they move upstream into lake Sammamish or downstream into lake Washington or perhaps split in distribution to their initial rearing area? We would assume the sockeye fry coming from the Issaquah creek system would rear in lake Sammamish but how sure are we? How does the presmolt population rearing in lake Sammamish compare to that rearing in lake Washington? Attempting to unscramble the presmolt mix is a challenging task and with the varying spawning times, incubation spring water environments mixed with surface water temperatures and available food levels almost an impossible task?

12 I suggest pick a few areas of research that can reasonably be resolved and focus on those and leave some tasks unanswered. Sorry I had to pass the stinky issue of olfactory sense on to you but I thought it would help build fences between spawning populations.

Sincerely,

Paul R Olson

Paul R. Olson

Responses to Comment Letter PO (Paul Olson)

PO-1. Comment noted.

PO-2. Comment noted. There have been several sources of sockeye eggs used to establish sockeye runs in the Cedar River/Lake Washington system, including Cultus Lake. Genetic evidence suggests that of all the sources, Baker Lake has had the most influence on existing sockeye populations in Lake Washington (Spies, 2002).

PO-3. The discussion of beach spawners is part of a larger discussion on straying and the likelihood that Cedar River hatchery sockeye may stray to other populations and have a negative biological impact on those populations. The worst case analysis considered a beach spawning population close to the Cedar River as such proximity would increase risk of straying impacts. There have been other areas where beach spawning has been observed including the Bellevue area, near Juanita Point, along Enatai Beach and around the shoreline of Mercer Island. Beach spawners may be found in other areas as well. Since the data suggest there is little or no straying to Bear Creek, and it is likely that risk of straying decreases with increased distance from the Cedar River, it is unlikely that many Cedar hatchery fish stray to the north end of the Lake.

If, in the future, it is found that there is an increase in straying to Bear Creek, then investigations focused on possible straying to the north end of the Lake may be appropriate. This would be considered under adaptive management.

PO-4. Comment noted. This comment addresses an issue which is outside the scope of this SEIS (one of the underlying mechanisms for homing of salmonids). This SEIS is limited to issues that SPU was directed to address by the Hearing Examiner. Please refer to General Response No. 1.

PO-5. The commenter has raised a question that is being addressed through ongoing research and monitoring. Since fish passage facilities were completed two years ago, a portion of the sockeye ascending the ladder were used for broodstock. Otoliths were removed from these fish after spawning, which allowed scientists to determine what proportion were of hatchery origin. Further information on the effects of fry release location on subsequent adult spawning location may be found in a report by Fresh et al. (2003). The worst case analysis assumed that hatchery releases would return to sites in the Cedar River that may be different than they would be if the fry were naturally produced.

PO-6. Comment noted.

PO-7. Comment noted. Seattle Public Utilities agrees that homing is thought to rely, in part, on chemical cues in the water that allow salmon to home to specific locations.

PO-8. The worst case analysis on straying, described in Section 3.2.2 of the SEIS, similarly concludes that straying to Bear Creek is likely to be at very low levels. Their conclusions, however, were based on three years of data that found no identified hatchery strays in Bear Creek.

PO-9. Comment noted. Most mortality occurs during incubation in the salmon life cycle. Mortality during incubation results from various causes, including predation. The scientists involved with the worst case analysis did not identify *Hydra* as a significant source of predation. A search of the Fisheries and Aquatic Sciences database resulted in only two articles on the feeding ecology of *Hydra oligactis*. This organism preys on *Daphnia*, a species of zooplankton found in lakes, and has been known to prey on bluegill. No references resulting from this search addressed effects on salmonid alevins or fry. If *Hydra* is a factor in the mortality of sockeye in the Cedar River, no information could be found to describe its effects.

PO-10. The predation analysis relies on the worst case analysis workshop results. The scientists thought that the higher numbers of sockeye fry resulting from the hatchery were more likely to reduce predation rates on Chinook, so long as outmigration timing was similar. Broodstock carcasses are returned to the river to provide nutrients to the system as they would if they had spawned naturally. This comment will be provided to the Technical Work Group for further consideration.

PO-11. This section of the AMP discusses the need to compare the size and growth of wild-spawned and hatchery fry and smolts. This section suggests, as does the commenter, that it may be necessary to, "quantify the size of fry from northern lake tributaries to determine if any differences exist between Cedar River and other sockeye fry populations." In recent years, WDFW has operated a juvenile trap in Bear Creek and used the results to estimate the production of sockeye fry. The AMP discusses the implications of having multiple sources of unmarked fry. This discussion will be part of the study design work undertaken during the adaptive management process.

PO-12. Comment noted.

From: Adrienne Ross <adrienne@wolfenet.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/21/2005 10:58:23 AM
Subject: "Official Comment to the Cedar River Sockeye Hatchery SEIS"

Chuck Clarke,
Director of Seattle Public Utilities

Dear Mr. Clarke,

1 I oppose building a sockeye salmon hatchery on the Cedar River and believe the City□s funds would be better spent on a broad range of habitat restoration that will benefit endangered Chinook salmon as well as other salmon and fish using the Cedar River. My position stems from a review of the SEIS as well as several years of (volunteer) experience on salmon restoration projects, including monitoring local runs on Bear Creek, Longfellow Creek and other Seattle / King County streams.

2 As you know, WRIA 8□s plan for Chinook recovery was released while the SEIS was being completed. Understandably, the WRIA plan does not assess the hatchery□s impacts to Chinook recovery. Unfortunately, nor does the SEIS provide an adequate review or analysis of the hatchery□s impact on Chinook recovery. This is in spite of the fact that NOAA□s Puget Sound Chinook Technical Review Team (TRT) has identified the hatchery as a major uncertainty in WRIA 8□s recovery plan, and has also concluded that of the 22 existing Chinook populations in Puget Sound, none are expendable. The NOAA TRT identified the Cedar River as being in the highest tier of concern and need for recovery of local Chinook stocks.

3 The hatchery□s potential impact on Chinook recovery is not included in the SEIS□ "worst case scenarios." If the hatchery succeeds in adding an additional 34 million sockeye fry annually at the same time that WRIA 8 increases Chinook populations, it is far from clear if Lake Washington has enough food to support both populations at sustained levels, or whether the increased sockeye numbers will cause sockeye to spawn on top of (and potentially harm) Chinook redds, or whether Chinook will be forced to spawn in poor quality habitat where high flows or scours could lower their reproductive success.

4 It is no secret in the restoration and scientific communities that hatcheries carry high risks of harm to salmon stocks. Two separate RSRP (NOAA□s highest level of independent ESA science advisory panels) have concluded that hatcheries carry high risks of negative effects. These findings only add to an already well-documented body of literature about hatchery problems. The SEIS admits that it will be virtually impossible to prevent the genes of the existing sockeye run from mixing with genes from hatchery fish, resulting in a less fit run. The City□s own studies show that hatchery fish are not comparable to wild or native fish. By ignoring these real and well-documented problems, the City and hatchery advocates run a very real risk of creating a genetically homogenized, less fit run of sockeye salmon while at the same time pushing an already endangered Chinook population closer to extinction.

5 Other questions that remain unanswered concern the hatchery□s funding. The recommended budget is for 10 years of operation, but the hatchery may operate for as long as 50 years. Where will this money come from? Also unidentified is where the City will find money to pay for habitat or other

5 fixes required if the hatchery does indeed harm local Chinook or other salmon runs. In particular, will this take City funding away from the WRIA 8 Chinook recovery plans?

6 I strongly urge the City to abandon the hatchery project and instead dedicate time, expertise and funding to a broad range of habitat restoration. By habitat restoration, I mean protection and restoration of floodplains, estuaries, riparian corridors and upland forests, and not simply side channels construction, LWD additions, stormwater treatments or other measures that only address a single species or one aspect of ecological processes. This is in keeping with an emerging Shared Strategy and WRIA 8 policy of habitat-based projects that will benefit multiple species of salmonids, including ESA listed Chinook. In the end, the best course is to foster a Cedar River healthy enough to protect and sustain chinook and sockeye, other native fish, and a diverse array of river and riparian invertebrates and other organisms.

Thank you,

Adrienne Ross
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Seattle, WA 98103
206-789-4012
Adrienne@wolfenet.com

Responses to Comment Letter AR (Adrienne Ross)

AR-1. Comment noted. This comment addresses the policy question of whether or not to construct the hatchery. While that is an appropriate question to be addressed by decision-makers, it is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Refer to General Response No.1 for a discussion of the scope of the SEIS. See also General Response No. 6 for information on habitat investments made by SPU on the Cedar River.

AR-2. Refer to General Response No. 6 for information about the WRIA 8 Plan and its relationship to the proposed project. Also refer to Letter TT, Responses 21 and 22.

AR-3. Please see Section 3 of the SEIS, which specifically discusses homogenization, food supply and competition in Lake Washington and superimposition. Also please refer to Letter TT, Response 30.

AR-4. Refer to Letter TT, Response 23. Refer to Letter TT, Response 26 regarding differences between natural and hatchery origin sockeye.

AR-5. For a discussion of proposed funding, please see Section 5.3 of the HCP, which includes funding for habitat investments as well as funding for the hatchery and the AMP. Also see General Response No. 5 and Letter TT, Response 31.

AR-6. Comment noted. This comment addresses the policy question of whether or not to construct the hatchery. While that is an appropriate question to be addressed by decision-makers, it is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Refer to General Response No. 1 for a discussion of the scope of the SEIS.

Refer to General Response No. 6 for a discussion of the City's participation in the WRIA 8 Plan and its habitat enhancement and restoration efforts.

Vikki Anselmo - Official comment to the Cedar River Sockeye Hatchery SEIS Page 1

From: "James M. Scanlan" <jscanlan@u.washington.edu>
To: <vikki.anselmo@seattle.gov>
Date: 3/18/2005 11:44:38 AM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

Chuck Clarke,
Director of Seattle Public Utilities

Dear Mr. Clarke,

1 I do not support constructing a sockeye salmon hatchery on the Cedar River. I urge Seattle Public Utilities and the City of Seattle to instead use these funds to support habitat restoration that will promote WRIA 8 and other Chinook recovery strategies.

2 Extensive scientific research (conducted by NOAA and others) shows that hatcheries carry risk for Chinook salmon. NOAA's Puget Sound Chinook Technical Review Team (TRT) identifies the hatchery as a "major uncertainty" in Chinook recovery efforts. Unfortunately, the recently released Supplemental Environmental Impact Statement (SEIS) does not address the hatcherys potential impacts on the Cedar Rivers Chinook stocks. As you know, NOAA holds that of the 22 existing Chinook populations in Puget Sound, none are expendable, and the Cedar Rivers runs are priorities for concern and recovery.

3 Other potential harms arising from the hatchery include: creation of a genetically homogenized (and therefore less fit) run of sockeye salmon; uncertainties surrounding long-term funding, especially if habitat restoration is mandated due to harms to the local Chinook runs; whether the Cedar River and Lake Washington can support massively increased sockeye populations, especially whether enough food exists and whether sockeye salmon would spawn on top of (and harm or destroy) Chinook salmon redds.

4 Rather than building a hatchery for a non-native run of sockeye, I believe the public interests would be better served by habitat restoration that will benefit multiple species of ESA listed native fish.

Thank you for reviewing my comments.

Sincerely,

James M. Scanlan. Ph. D.

****
James M. Scanlan, Ph.D.
U. of Washington Health Sciences Center
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Box 356560, Seattle, WA 98195
Phone #:(206) 685 9941, Fax:(206) 543 9520
****

Responses to Comment Letter JS (James Scanlan)

JS-1. This comment addresses the question of whether or not the construction of the hatchery is a wise public policy decision. While that is an appropriate question for decision-makers, it is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Please refer to General Reference No. 1.

Alternatives for sockeye mitigation were previously evaluated in the HCP EA/EIS are outside the scope of the SEIS.

Comment noted. Please refer to General Response No. 6 for a discussion of SPU's participation in the WRIA 8 Plan, and in regional habitat enhancement and acquisition efforts including its habitat investments to date.

JS-2. Refer to Letter TT, Responses 21 and 22. See also Section 2.4 of the FEIS and Section 3 of the FSEIS.

JS-3. Please see Section 3 of the SEIS which specifically discusses homogenization, food supply and competition in Lake Washington, and superimposition. Also refer to Letter TT, Response 30.

See Section 5.3 of the HCP, which includes funding for habitat investments as well as funding for the hatchery and the AMP. Also refer to General Response No. 5.

JS-4. Comment noted.

Vikki Anselmo - Page 1

From: <jeffstern9@aol.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/21/2005 9:27:47 AM

I do not want to see a high cost sockeye salmon hatchery experiment on the Cedar River that could undermine Chinook recovery in Puget Sound while compromising the wild sockeye populations in the river.

1 I strongly recommend that the City of Seattle not pursue building a sockeye salmon hatchery. Instead, in keeping with emergent WRIA 8 policy, funding that would be used for the hatchery should instead be dedicated to habitat-based projects that will benefit multiple species of salmonids and other fish, especially ESA listed Chinook salmon, rather than into a hatchery designed to benefit a non-native stock of sockeye salmon.

2 The WRIA 8 plan for Chinook salmon recovery was released while the SEIS was being completed. It does not assess the hatchery impacts to Chinook recovery nor does the hatchery SEIS provide adequate analysis of the hatchery□s impact on Chinook salmon recovery. As a result, NOAA□s Puget Sound Chinook Technical Review Team (TRT), however, has identified the hatchery as a major uncertainty in WRIA 8's recovery plan. The TRT has concluded that of the 22 extant Chinook populations in Puget Sound, none are expendable, and that the Cedar River is in the highest tier of concern and need for recovery amongst all Puget Sound stocks. Shared Strategy is promoting a WRIA 8 funding policy that would use mitigation funds for habitat-based mitigation measures to help support the large funding costs needed for Chinook recovery.

3 Further, two reviews conducted by two separate RSRP (NOAA s highest level of independent ESA science advisory panels) have concluded in two separate reports that hatcheries carry high risks of negative effects. (One report was published in Science in 2004, and the other is an internal memo.) Their findings add to the already extensive body of literature about hatchery problems. These are documented risks that the City of Seattle and hatchery advocates downplay or ignore at the risk of further impacting an already severely depressed or endangered Chinook population.

Responses to Comment Letter JE (Jeff Stern)

JE-1. Comment noted. This comment addresses the policy question of whether or not the construction of the hatchery is a wise public policy decision. While that is an appropriate question for decision-makers, it is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner.

Alternatives for sockeye mitigation were previously evaluated in the HCP EA/EIS and are outside the scope of the SEIS.

Please refer to General Response No. 6 for a discussion of SPU's participation in the WRIA 8 Plan, and in regional habitat enhancement and acquisition efforts.

JE-2. The Cedar River Sockeye Hatchery is included in the approved HCP. NOAA Fisheries (NMFS) reviewed the HCP, and issued a Biological Opinion on the effects of the HCP, including those of the sockeye hatchery on Chinook. The NMFS states that "potential adverse effects to PS chinook from sockeye supplementation are expected to be slight." (p.99, Biological Opinion, April 2000).

NOAA Fisheries is a Party to the LMA and will be a major decision-maker for hatchery operations and the AMP.

Refer to General Response No. 6. Also refer also to Letter TT, Responses 21 and 22.

JE-3. Refer to Letter TT, Response 23.

Vikki Anselmo - OFFICIAL COMMENT TO CEDAR RIVER SOCKEYE HATCHERY SEIS Page 1

From: <Sstewart286@aol.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/20/2005 11:35:20 PM
Subject: OFFICIAL COMMENT TO CEDAR RIVER SOCKEYE HATCHERY SEIS

1 I find it irresponsible and incredible that the City continues to believe that this hatchery is a good idea. It is clear that the hatchery will adversely affect (if not completely eliminate) the natural runs of Chinook in the Cedar River. It is also clear that these hatchery raised ("farmed") fish are weak, due in part because they are genetically homogenized. And, of course, we all know that this folly will cost the taxpayers tons of scarce dollars. Those dollars are much better spent to improve existing habitat or create additional habitat for the natural runs of Chinook. As I recall, the city has already committed to improve habitat--but has done little. Perhaps, it's time to live up to these old promises instead of getting into the new business of farming fish.

2 I would also like to say that I know that the sports fishermen and other supporters of the hatchery are well organized in their letter campaigns. However, this decision should not be based on a popularity contest; it should be based on doing "what's right"--as established by science. The fisheries biologists I know (and they are not hired guns) all agree that this is a "wrong" thing to do.

Thank you for considering this comment.

Responses to Comment Letter SS (Sstewart286@aol.com)

SS-1. Comment noted. Alternatives for sockeye mitigation were previously evaluated in the HCP EA/EIS and are outside the scope of the SEIS; refer to General Response No. 1. The FEIS and SEIS disclose potential impacts to Chinook salmon. Chapter 3 of the SEIS discusses potential impacts to Chinook resulting from predation, food supply and competition, superimposition, and spawning ground competition as directed by the Hearing Examiner's decision. Please also see Letter TT, Response 23 related to the likely inherent hatchery effects and Appendix C, which has been added to Part 1 of this FSEIS to provide information on this issue. Refer to General Response No. 6 for a discussion of the City's participation in the WRIA 8 Plan and regional habitat enhancement and acquisition efforts.

This comment also addresses the question of whether or not the construction of the hatchery is a wise public policy decision. While that is an appropriate question for decision-makers, it is not directly relevant to the question of whether or not the SEIS adequately describes the AMP as mitigation, or presents a worst case analysis as required by the Hearing Examiner.

SS-2. Refer to General Response No. 3 for a discussion of the workshop process that provided input on the risks associated with the hatchery. See also Appendix B for summaries of the workshop discussions.

Vikki Anselmo
Seattle Public Utilities
700-5th Ave. Suite 4900
PO Box 34018
Seattle WA 98124-4018

OFFICIAL COMMENT TO THE CEDAR RIVER SOCKEYE HATCHERY SEIS

1 I , John L. Sullivan, have lived near or on the Cedar River for over 50 years. Currently I have 200+ feet of river frontage near Maple Valley where I reside. I have fished the Cedar River over the years when fishing season was open.

2 Now we land owners on the river are told, due to the new CAO ruling, we are not allowed to grow any non-indigenous plants or trees along the river. "THEY", or CAO want only original growth. This brings me to my point in writing this letter.

3 I think a fish hatchery would be a good thing. My question is: What about the indigenous fish in the Cedar River? You must be aware that the Sockeye Salmon is NOT indigenous to the Cedar River. Or did you not know that?

Indigenous fish to the Cedar River are the King Salmon, Coho Salmon, Silver Salmon, Summer and Winter Run Steelhead, Whitefish, Native Rainbow and Cutthroat Trout and Squawfish. These native fish have been allowed to become almost extinct. In the 1950's a person could walk across the mouth of the Cedar River on the backs of the King Salmon. They provided a great fishery for Lake Washington.

4 In the future when considering investing in habitat restoration programs, PLEASE hire or use knowledgeable people to implement the projects. I could list several projects where several hundred thousands of tax payers dollars were wasted.

5 One project was near my home. A group planted vegetation on a bank of the river that had been rip-rapped. I told the project manager that the plants would be washed away during the winter high water. It was.

6 Most of the people running these projects have only book learning or seemingly great ideas and no real experience at seeing and watching the whole river eco-system.

7 I have a hard time reading about your hatchery proposal. Many state agencies are all for indigenous flora and fauna, I do not see it happening on my stretch of the river.

Sincerely,

John L. Sullivan

John L. Sullivan
20222-218th PL SE
Maple Valley, WA 98038

425-432-0602 home
206-399-2958 cell

P.S. Please feel free to call me to discuss this.

Proposed Landsburg hatchery project is one step closer to happening

By Kathleen Kerr

For the past several years Seattle Public Utilities (SPU) has been in the process of developing plans to place a permanent Sockeye hatchery on this Cedar River at Landsburg, and have come one step closer towards making that project happen with the newly completed Draft Supplemental Environmental Impact Statement (DSEIS).

"The sockeye hatchery, along with habitat investments in the lower Cedar River, is part of the Cedar River Watershed Habitat Conservation Plan," said DEIS project manager Judith Noble.

After several years of putting the fishery environmental documents together, a Final Environmental Impact Statement (FEIS) was issued for the Project on March 20, 2003. However, the FEIS was appealed and the Seattle Hearing Examiner required additional work in two areas to complete the environmental review process. As a result, a DSEIS has been completed, which addresses the issues by providing:

•A discussion of Adaptive Management Plan for the hatchery, and

•Worst case analyses for several potential environmental impacts that could occur as a result of the new hatchery.

Copies of the DSEIS for the proposed Project are now available at the following locations in this area: Maple Valley Public Library, 21844 S.E. 248th St.; Fairwood Public Library, 17009 140th Ave. S.E. and Renton Public Library, 100 Mill Ave. South. Single copies (either paper or CD) are also available free of charge, with additional copies being provided at cost. Contact Vikki Anselmo of SPU at 206-386-4560 for a copy. The document is also available online at: *http://www.seattle.gov/utilities/About_SPU/Adec.asp*.

Public comments will be taken *on Thursday, March 10 from 7 to 9:30 p.m.* with staff being available to answer questions *from 6:30-7 p.m.* Location of the hearing: Renton Technical College, 3000 NE 4th St., Renton; Blenson Auditorium, Building C.

Written comments can also be directed to Vikki Anselmo, Seattle Public Utilities, 700 5th Ave., Suite 4900, P.O. Box 34018, Seattle, WA 98124-4018; or email to *vikki.anselmo@seattle.gov* with subject line clearly stated: **Official comment to the Cedar River Sockeye Hatchery SEIS.** *All comments must be postmarked no later than Monday, March 21, 2005.*

Parade entrants are being sought

Maple Valley Days committee is looking for parade entrants. There are seven divisions - Business/Floats/Novelty, Motor Vehicle (commercial, classic, Drill Team, Equestrian Unit, Marching Band/Music, Youth, and Service/Neighborhood. Everyone is welcome to participate, you are sure to have a great time, there will be awards given out to the best entrant for each division. Go to *www.maplevalleydays.com/ <directory/ www.maplevalleydays.com>* to learn more about the parade, and fill out a parade application, they look forward to seeing you this year!

Responses to Comment Letter SU (John Sullivan)

SU-1. Comment noted.

SU-2. Comment noted.

SU-3. Please see Section 3 of the SEIS that discusses potential impacts of the sockeye hatchery on native Chinook. The origin of sockeye in the Cedar River is discussed in Section 2.4.2 of the FEIS.

SU-4. Comment noted. The comment addresses an issue that is beyond the specific issues that the Hearing Examiner directed must be evaluated as part of the worst-case analysis in the SEIS. Refer to General Response No. 1 for a discussion of the scope of the SEIS. See also workshop summaries in Appendix B for a list of the scientists whose discussion informed the worst case analysis.

SU-5. Comment noted.

SU-6. Comment noted.

SU-7. Comment noted.

From: Jim Switt <jimswitt@yahoo.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/16/2005 9:14:53 PM
Subject: Official Comments to the Cedar River Sockeye SEIS

Dear Ms. Anselmo,

1 I am writing to express my concern about the proposed Cedar River sockeye hatchery. The draft SEIS is flawed because it fails to accurately portray risk. The AMP is also flawed and grossly underfunded (else you wouldn't have enough money to build the hatchery).

2 The hatchery is a waste of money best spent on habitat which the Cedar needs more than a hatchery that's not likely to work.

Sincerely,

Jim Switt

3 PS I am a fisherman and love to fish for sockeye. But I feel the river and fish NOT a fishery should come first and all the science I've seen tells me a hatchery is a crap shoot..

Do you Yahoo!?
Yahoo! Small Business - Try our new resources site!

Responses to Comment Letter JI (Jim Switt)

JI-1. Refer to Section 1.6.2 of the SEIS and General Response No. 3 for a discussion of how the worst case analyses were conducted in response to the Hearing Examiner's direction to provide a better analysis of risk for specific impacts.

Refer to Letter TT, Response 4 for a discussion of how risk and uncertainties have been addressed in the AMP. Refer to General Response No. 5 for a discussion of funding for the AMP.

JI-2. This comment addresses the question of whether or not the construction of the hatchery is a wise public policy decision. While that is an appropriate question for decision-makers, it is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Alternatives for sockeye mitigation were previously evaluated in the HCP EA/EIS and are outside the scope of the SEIS. Refer to General Response No.1.

Refer to General Response No. 6 for a discussion of the City's participation in habitat enhancement and restoration efforts.

JI-3. Comment noted.

/ikki Anselmo - Cedar River Sockeye Salmon Hatchery Page 1

From: robert c wissmar <wissmar@u.washington.edu>
To: <vikki.anselmo@seattle.gov>
Date: 3/21/2005 6:21:09 PM
Subject: Cedar River Sockeye Salmon Hatchery

1 The Seattle Public Utilities Supplemental Environmental, regarding the Impact Statement for the Sockeye Salmon Hatchery that is Proposed for the Cedar River, presents unclear reasons for the construction of the hatchery.

Why have managers approached the salmon issues with tunnel vision? As a result, they are committed to a hatchery alternative when a preponderance of scientific research indicates that habitat oriented approaches are likely to be less costly and more effective.

2 I vote NO for the Cedar River Sockeye Salmon Hatchery and YES for a more balanced perspective that evaluates habitat protection and restoration alternatives in addition to hatchery alternatives.

NEW BOOK: http://www.fisheries.org/publications/catbooks/x55044.shtml

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CC: robert c wissmar <wissmar@u.washington.edu>

Responses to Comment Letter RW (Robert Wissmar)

RW-1. Comment noted. This comment addresses the question of whether or not the construction of the hatchery is a wise public policy decision. While that is an appropriate question for decision-makers, it is not directly related to either the worst case analysis or the AMP, the subject matter of this SEIS, as directed by the Hearing Examiner. Refer to General Response No. 1 for a discussion of the scope of the SEIS.

Project objectives are provided in Section 1.3 of the SEIS. For further background on the decision to select a hatchery as part of the mitigation alternative, please see the HCP, Section 4.3.

RW-2. Comment noted. The sockeye mitigation alternative includes investment in habitat along the lower Cedar River. The HCP includes significant improvements and protection of habitat above Landsburg Dam. Alternatives for sockeye mitigation were evaluated in the EA/EIS.

The following comments received on the DSEIS express support for the proposed project, citing issues such as economic benefits, effects on recreational fishing, and other issues. These comments are outside the scope of the SEIS. A response of "comment noted" applies to all of the following comments.

Comment Letter GR

From: "Alvarez, Lynda" <alvarez.l@ghc.org>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/10/2005 12:59:20 PM
Subject: Official comment on the Cedar River Sockeye Hatchery SEIS

Good day Ms. Anselmo,

1 I am a member of WDFW Steelhead-Cutthroat Policy Advisory Group, as well as the Green River Steelhead Trout Club. The Green River Steelhead Trout Club would like to add their support of the hatchery project.

Thank you kindly,

Lynda Alvarez
12019 124th Ave Ct E
Puyallup, WA 98374
253.770.7880

CC: "Floor, Tony" <tony@nmta.net>, "Gilchrist, Mike" <mikegilchrist@comcast.net>, "Johnson, Chuck WDFW" <johnscwj@dfw.wa.gov>, "McCartney, Cheryl" <mccarcam@dfw.wa.gov>, "McLaughlin, John" <jarmack@comcast.net>, "Muns, Clint" <fishhog211@aol.com>, "Ryan, Kevin D" <kevdryan@earthlink.net>, "Thompson, Walt" <wedell@msn.com>, "Barber, Harry" <hab30a@netzero.net>, "Beth Spelsberg" <bspelsberg@comcast.net>, "Bob Reid" <cpr-fish@toledotel.com>, "Boynton, Hal" <fishaholic9@juno.com>, "Burge, Dick" <fskibum@olypen.com>, "Buzz Johnson" <buzzajohnson@comcast.net>, "Conroy, Edward" <aandeconroy@techline.com>, "Dean Oakes" <oakesdean@aol.com>, "Evensen, John" <evensenjc@msn.com>, "Habenicht, Fred" <fishonfred@tenforward.com>, "Hearn, Jim" <unkjim813@msn.com>, "Hoppler, Wes" <hopspot@aol.com>, "Hugh Evans" <hoe@ecl-law.com>, "John Sharf" <jandksharf@aol.com>, "Kelly, John" <jksteel1@comcast.net>, "Mantua, Nathan" <mantua@atmos.washington.edu>, "McRoberts, James" <jim4fish@comcast.net>, "Michael Golik" <golikmg@netzero.com>, "Miyawaki, Leland" <miyawaki@iswnet.com>, "Mueller, Dana" <Dana_A_Mueller@rl.gov>, "Paul Opperman" <fish@paul.opperman.net>, "Rhubright, Mike" <MPRhubright@msn.com>, "Sam Ingram" <susanjiam@earthlink.net>, "Schaad Doug" <dcschaad@comcast.net>, "Simonseth, Brian" <homer2handed@hotmail.com>, "Soverel, Pete" <psoverel@wildsalmoncenter.org>, "Tingley, Ron" <ting@fidalgo.net>, "Tucker, Phil" <tuckerps@nas.com>, "Turner, Terry" <tnturner@comcast.net>, "Urabeck Frank" <urabeck@comcast.net>, "Way, Dennis" <denjanway@msn.com>, "Dave Croonquist" <dcroonquist11@msn.com>

Comment Letter KC

From: <Salmtrutta@aol.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/20/2005 8:15:44 PM
Subject: Official comments to the Cedar River Sockeye Hatchery SEIS

KING COUNTY OUTDOOR SPORTS COUNCIL

March 20, 2005

Vikki Anselmo, SPU
700 - 5th Ave.
Seattle,WA 98124

1 The King County Outdoor Sports Council strongly supports the concept of a permanent sockeye hatchery on the Cedar River.

2 It seems to us that opponents of the proposal fail to recognize that the "natural ecosystem" function of the Cedar River ceased with the building of the Hiram Chittenden Locks, raising the water level of Lake Washington, ceasing the flow of the Black River to the Green River, building two dams on the Cedar and a small power generation plant. Does anyone really think there is a natural ecosystem left to save?

3 It is well known the Cedar River sockeye run really started in the 1930's with the introduction of fish from the Baker River. Prior to the construction of the Chittenden Locks there may have been a natural run of sockeye that used the Black River to access the Cedar spawning grounds. With the diversion of the Black River, from Lake Washington, this run was forced to access the Cedar through the locks. I believe the scientific community has consensus the Baker River fish have overwhelmed any remnant population of sockeye from the Black River.

4 What is important about the hatchery is the revenue it brings to the state.The Washington Department of Fish & Wildlife gains, through the sale of fishing licenses, and the local economy through the sale of recreational equipment. Both of which have immediate economical impacts. Additionally, the U.S. Fish & Wildlife Service, through taxes on the sale of recreational equipment, pro-rated on the number of fishing licenses sold in each state, returns several million dollars to the state annually as well.

5 Fishermen love to catch fish and this resource, Lake Washington sockeye, is one that brings hundreds of fishermen out. It is good family fun and we certainly need more resources like it.

The King County Outdoor Sports Council was founded in 1933 and is composed of 12 sports clubs with over 10,000 members.

Sincerely,

Jim Ledbetter, President
8029 - 36 NE
Seattle, WA 98115-4824
206-523-0095

Comment Letter MT

NORTHWEST MARINE TRADE ASSOCIATION

1900 N. Northlake Way, Suite 233
Seattle, WA 98103-9087

Phone: (206) 634-0911
Fax: (206) 632-0078

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John Wedeberg & Associates

Dave Young
Volvo Penta of the Americas

Bill Youngsman
Twin Bridges Marina

Promoting the Recreational Boating Industry in the Pacific Northwest

March 1, 2005

Ms. Vikki Anselmo,
Seattle Public Utilities
700 5th Avenue, Suite 4900
P.O. Box 34018
Seattle, WA 98124-4018

Dear Ms. Anselmo,

1 Please accept this letter as support to move ahead with the construction of a sockeye salmon hatchery on the Cedar River system.

2 The Northwest Marine Trade Association represents over 870 businesses dedicated to recreational boating and fishing. Boating and fishing is big business in Washington State and by supporting a sockeye production facility, our members directly and indirectly benefit from a Lake Washington sockeye salmon fishery.

But the real winner is the general public. The Lake Washington sockeye salmon fishery provides a greater economic benefit in an urban environment that any other salmon fishery in our state. It also provides some great fishing and fun for families throughout the Puget Sound region.

We know that without a sockeye salmon production facility, the likelihood of entertaining an annual fishery is greatly diminished. Therefore, we urge you to do support the proposed sockeye salmon hatchery.

3 Please feel free to contact me if we can help in any way. Through out Director of Fishing Affairs, we have followed this issue for many years and we are hopeful that decisions made in the coming weeks will ensure that the permanent hatchery is approved and built.

With warm regards,

Michael Campbell
President

cc: Mayor Nickels
Seattle City Council

Comment Letter MV

Greater Maple Valley-Black Diamond Chamber of Commerce, Inc.

Serving the Community Since 1965

March 10, 2005

Vikki Anselmo
Seattle Public Utilities
700 5th Avenue, Suite 4900
P. O. Box 34018
Seattle, WA 98124-4018

Dear Ms. Anselmo:

1 This letter is in regard to the "Official comment to the Cedar River Sockeye Hatchery SEIS".

The Greater Maple Valley-Black Diamond Chamber of Commerce supports the proposed Cedar River Sockeye Hatchery Project at Landsburg on the Cedar River in King County. A permanent hatchery supports an economic development plan that embraces our rivers, trails, lakes, and recreational opportunities that our Chamber believes will benefit the residents of Southeast King County. We know that the Cedar River Trail from Renton to Landsburg is a regional attraction and even a greater attraction when the sockeye are running. The possibilities are endless for education, celebration, and community partnerships that would ensure the future health and vitality of the Cedar.

We stand in strong support of the hatchery and ask that we be added to any mailing or notification list so that we can continue to support the efforts to build this hatchery.

Respectfully,

Debbie Malone
President

The Chamber: Connect, Communicate, Collaborate!
P O Box 302 • Maple Valley, WA 98038
PH: 425.432.0222 • FAX: 425.413.8017
mvbd@vircom.net • www.maplevalley.com • www.blackdiamondwachamber.org

From: <sbarrie313@comcast.net>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/20/2005 1:32:30 PM
Subject: Cedar River Sockeye Hatchery

1 I submitted a written endorsement for the Cedar River Sockeye Hatchery back on October 15, 2002. As I stated in my letter then, my family and I have been enthusiastic Sockeye fishers for nearly 40 years, and I hope that my Grandchiidren and their Grandchildren will be able to enjoy this universally unique fishery that the Lake Washington Sockeye fishery affords. To assure that this fishery continues and is sustainable, hatchery supplementation is required to overcome the environmental degradation of Lake Washington that the increasing population in the Seattle area is causing. The permanent hatchery will mitigate the loss of 17 miles of riparian habitat above Landsburg, This hatchery will be designed to be the most technically correct and scientifically sensitive facility ever built.

2 The valuable economic benefits derived from the Lake washington Sockeye fishery by thousands of enthusiastic Puget Sound residents and the Treaty Tribes that participate in the fishery should be justification to ensure that this fishery continues and expands to afford an ongoing annual fishery.

Sincerely,

Alan Barrie
2815 78th Ave. Ct. NW
Gig Harbor, WA 98335

From: "Dusty Routh" <fishdusty@comcast.net>
To: <vikki.anselmo@seattle.gov>
Date: 3/5/2005 1:10:29 PM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

Dear Ms. Anselmo,

1 I am writing in support of the Cedar River Sockeye Hatchery.

While I've enjoyed this fishery in the past when it's been opened as a private angler, more importantly over the past few seasons I've taken children from the Ryther Child Center in Seattle out on Lake Washington to participate, also. I'm a volunteer with Ryther in the summers on a weekend basis, where I provide fishing trips to these foster children who are housed at Ryther. As you may or may not know, Ryther provides a group home environment for traumatized foster children who are without parents or who have parents who cannot or are not allowed to be with them. We started this program several years ago, mostly on an informal basis as time allowed and as Ryther case workers were able to go on the trips with the children.

2 The Lake Washington sockeye season presents a perfect opportunity for taking these under-priviledged children fishing. First, it's close to Seattle, so transportation isn't an issue. Second, the fishing is good and the fish are big enough to give the kids some real bragging rights when they return at the end of the day. Third, despite the trauma these children have gone through, the experience of fishing and catching fish never fails to put a smile on their faces.

3 While having a long and productive sockeye fishery in the summer on Lake Washington every year could someday be a dream come true for thousands of Seattle-area anglers, it would be particularly good for the kids at Ryther and, hopefully, other programs like this with other non-profit children's groups that could be organized as well.

Many thanks for your support and consideration.

Sincerely,

Allan Dusty Routh
Ph: 425-271-4675

Comment Letter AT

From: "Denise and Aaron" <63deniserae@my-netlink.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/13/2005 5:55:42 PM
Subject: Official comment to the Cedar River Sockey Hatchery SEIS

Dear Ms. Anselmo

1 Denise and I whole heartedly support the proposed new sockey hatchery on the Cedar River. I have lived in the Seattle area my entire life (38 yrs), and cannot think of a recreational sporting event that parallels the Lake Washington sockey fishery. Men and women alike watch the fish count at the looks with anticipation. Last year, the guys at work and I were trying to come up with a formula to speculate what day the fishery would open, based on the previous days counts.

I can only imagine the dollars that the fishery brings to the state the rare years that it does open. My folks have had friends from out of state come and stay with them to partake in the hoopla. I'll bet the local sporting good stores could stay open for the month of July purely on the sale of sockeye gear and licenses alone.

Thank you for the opportunity to comment.

Aaron J Thress and Denise Sherman
Monroe, WA

CC: "Kelli Mack" <kthress@msn.com>

Comment Letter BB

From: Bill Brown <bbrown@soundair.com>
To: "'Vikki.Anselmo@seattle.gov'" <Vikki.Anselmo@seattle.gov>
Date: 3/9/2005 10:51:53 AM
Subject: FW: Official comment to the Cedar River Sockeye Hatchery SEIS

> ----Original Message----
> From: Bill Brown
> Sent: Wednesday, March 09, 2005 10:31 AM
> To: 'Vikk1.Anselmo@seattle.gov'
> Subject: Official comment to the Cedar River Sockeye Hatchery SEIS
>
> To whom it may concern:
>
1 > My family and friends have been fishing for sockeye in Lake Washington,
> when they are available, for over 30 years.
> The enjoyment of such a fishery in the center of Seattle Metro is a boon
> to our economy, our tax base, and how
> we are viewed around the country. Just think how many fish licenses, boat
> fuel, food, fish gear, motel/hotel rooms,
> etc. will be purchased every July because we had the foresight to build
> and operate the sockeye fish hatchery. Just
> think of the additional jobs that would be created.
>
>
> The hatchery is a necessity to grow this fishery and it has been shown
> through the SEIS to have no adverse impact
> on other species of fish.
>
> Let's quit wasting time and go forward with this project as soon as
> possible.
>
>
> Bill Brown
> Soundair, Inc.
> bbrown@soundair.com
>

Comment Letter BF

From: "Butch &. Kay" <bkayfearing@foxinternet.net>
To: <vikki.anselmo@seattle.gov>
Date: 3/9/2005 9:56:07 AM
Subject: cedar river hatchery

Offical comment to the cedar river Sockeye Hatchery SEIS
TO; Vicki Anselmo.
My name is Buford Fearing and I am a member of the sno-king Pudget sound anglers.
I am writing you of the proposed dismantling of the temporary sockeye hatchery on the cedar river. I
believe this would be a hugh mistake. the lake washington sockeye run is very unique to this region.I must
say that I enjoy fishing the run when it is open on the lake. This in my opinion is the last chance to save
1 the lake washington sockeye run. Close the temporary hatchery down and it is all over, and my
grandchildren will never get a chance to enjoy it as I have. I strongly urge the building of the permanent
hatchery on this river system. I understand that one woman is standing against this move, and she should
not be able to destroy something beautiful and natrual to our area.
I appreciate your consideration on this issue
sincerely Buford Fearing

Comment Letter BL

From: "Bob Lawson" <robert.lawson@comcast.net>
To: <vikki.anselmo@seattle.gov>
Date: 3/7/2005 9:15:33 PM
Subject: "Official Comment to the Cedar River Sockeye Hatchery SEIS"

Dear Vikki

Boy I'm glad I found out how to make a comment.

I was born in 1949 at what was Renton Hospital, later K Mart. Now I hear it is being replaced. I have
fished the Cedar River since I was 15. I caught my first steelhead in the Cedar in about 1979. I have
fished every day every Sockeye season has been open.

I really can't fathom why anyone would not promote a permanent hatchery for enhancing the sockeye
fishery on Lake Washington. I don't know the exact figures, but I spend a lot of money during sockeye
1 time. I'm sure you know the dollar figure infused into our local economy for every sports fisherman
opening on the lake.

More people enjoy that lake at the best time to be on it of the year.

In my opinion, we need that hatchery. Let Seattle enyoy our lake. Let us spend more money more often
and for longer openings. What could be the downside?

Bob Lawson
206 824 5660

Comment Letter BP

From: <SPasin@aol.com>
To: <vikki.anselmo@Seattle.gov>
Date: 3/15/2005 11:34:07 AM
Subject: Offical comment to the Cedar River Sockeye Hatchery SEIS

1 We support the construction of the Cedar River Sockeye Hatchery. Please build it as soon as possible.

Also, if possible, the City of Seattle should encourage expansion and construction of more boat launch facilities on Lake Washington to facilitate fishing for Sockeye and other fish.

Sincerely yours,

Barbara and Stan Pasin
450 Mt. McKinley Dr. SW
Issaquah, WA 98027

Comment Letter CC

Judith Noble
Strategic Policy Office
Seattle Public Utilities
700 5th Ave. Suite 4900
PO Box 34018
Seattle WA 98124-4018

206-684-8078
Fax--206-684-4631

>>> Vikki Anselmo 3/28/2005 8:06:24 AM >>>
Another comment for review.

Vikki Anselmo
Seattle Public Utilities
Director's Office
(206) 684-5851 Main
(206) 386-4560 Direct

>>> < crciec@msn.com > 3/23/2005 9:58:14 AM >>>
As a lifetime resident of Washington, a registered and active voter, a family man and active and involved sportsman I would like to provide my input into the feedback process for the cedar river hatchery.

1 First of all I want to say that based on the scientific information that I have read carefully and what I know myself about fish and hatcheries it is overwhelmingly clear that the hatchery project should proceed immediately with no further delays. It really concerns me when a few individuals can affect the outcome of something so important and stall it with minimal scientific information. It concerns me as well that those who are in the decision making process do not use common sense and good judgement to stop those who are in the significant minority on this hatchery project.

2 I have worked on many habitat and fish restoration projects in Washington and do so to put back into the resource what me, my family and friends appreciate and enjoy so much. We enjoy the Lake Washington fishery and the opportunity to participate in the Sockeye fishery. There is no doubt that we will have a significantly improved fishery as a result of a new and improved hatchery on the Cedar River. It will provide opportunity and continue a way of life in our community that we all live for as residents of Washinton.

3 I want to make it clear that this is an important issue for me and my family as sport fishermen/women and lifetime residents of Washington.

I strongly urge you to proceed in an expeditious way with getting the hatchery project started and completed so that there is not a continued waste and impact on our fishery.

Myself and my family are available to support you with this project at any time. Please call and we will be there like we are for many other habitat and community projects here in our home state of Washington. We are proud of our state and want to continue to improve and support important projects which benefit all the residents of our state.

Your support with my request is appreciated!

Sicncerely,

Carl and Irene Carver
18912 SE 318th Place
Auburn Washington 98092
Phone: 253-630-3184

Comment Form

Cedar River Sockeye Hatchery Project
Draft Supplemental EIS
Public Hearing, March 10, 2005, 7:00 to 9:30 pm

Please provide us with your comments on the Draft Supplemental Environmental Impact Statement (EIS) for the Cedar River Sockeye Hatchery Project. You can complete this form and leave it in the box provided or mail to the address on the back. In addition, you can email your comments to vikki.anselmo@seattle.gov. Please state in the subject line "Official comment to the Cedar River Sockeye SEIS."

Comments on the Draft EIS must be submitted by 5 p.m. March 21, 2005.

1 Sockeye fishing has been One of
My favorite fishing Experiance Since
I was Introduced to it in 2002
Would Love To See Longer Seasons

Comment Letter CF2

Comment Form

Cedar River Sockeye Hatchery Project
Draft Supplemental EIS
Public Hearing, March 10, 2005, 7:00 to 9:30 pm

Please provide us with your comments on the Draft Supplemental Environmental Impact Statement (EIS) for the Cedar River Sockeye Hatchery Project. You can complete this form and leave it in the box provided or mail to the address on the back. In addition, you can email your comments to vikki.anselmo@seattle.gov. Please state in the subject line "Official comment to the Cedar River Sockeye SEIS."

Comments on the Draft EIS must be submitted by 5 p.m. March 21, 2005.

1 I HAVE LIVED IN THIS AREA FOR MORE THAN 30 years, AND HAVE FISHED SOCKEYE IN LAKE WASHINGTON AS LONG AS I CAN Remember. My Family has enjoyed on many occasion the excitement of being on the Lake and catching fish. I want to see my children have the opertunity to take there Children fishing and the only way this can happend is if there is a permanent hatchery to support this fishery I want to see a permant hatchery in place for all to enjoy

Thank You.

Comment Letter CH

From: Chris Davis <cm_davis@yahoo.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/7/2005 11:20:32 AM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

Vikki -

1 The Lake Washington Sockeye salmon season is an important event in my family. I have 2 young children that look forward to catching a salmon with their Dad and this season provides the best opportunity.

I support the hatchery and would like to see it up and running as soon as possible.

Thanks,
Chris Davis
20526 11th Dr SE
Bothell, WA 98012
425.488.5432

Celebrate Yahoo!'s 10th Birthday!
Yahoo! Netrospective: 100 Moments of the Web
http://birthday.yahoo.com/netrospective/

Comment Letter DB

From: David Beee <daveybeee@yahoo.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/8/2005 9:55:47 AM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

Dear Official,

1 I would like to voice my support for the Cedar river hatchery and love the oppurtunity to fish and preserve the fishery for future generations. Please position yourself in support of this action.

Thanks,
David Bergeron
PO Box 64651
Tacoma, Wa 98464
253-229-5816

Celebrate Yahoo!'s 10th Birthday!
Yahoo! Netrospective: 100 Moments of the Web

Comment Letter DC

From: "Dave Croonquist" <dcroonquist11@msn.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/7/2005 9:04:43 AM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

Ms. Anselmo:

1 I serve on both the Steelhead/Cutthroat Policy Advisory Group and the Puget Sound Recreational Fisheries Enhancement Oversight Committee for the Washington Department of Fish and Wildlife. I have been following the Cedar River Sockeye Hatchery issue for the past four years and would like to add my personal support to the project.

2 I grew up in Bellevue and spent many hours fishing off of docks in Lake Washington for kokanee and I am now looking forward to being able to pursue sockeye salmon on Lake Washington. Completion of the hatchery will open more opportunities for future fishing efforts on returning sockeye salmon by both sport and commercial fishers. The enhanced run will bring many dollars into the local economy while and will serve to keep fishing opportunities available to future generations. One only has to look at the number of boats on Lake Washington when there is a sockeye season to begin to realize the economic impact sport fishing has on the communities surrounding Lake Washington.

Thank you for the opportunity to comment.

Dave Croonquist

43 E Emerald Forest Lane

Sequim, WA 98382

360-682-1370

No virus found in this outgoing message.
Checked by AVG Anti-Virus.
Version: 7.0.308 / Virus Database: 266.6.3 - Release Date: 3/7/2005

CC: "Croonquist, David" <dcroonquist11@msn.com>, "Floor, Tony" <tony@nmta.net>, "Gilchrist, Mike" <mikegilchrist@comcast.net>, "Johnson, Chuck WDFW" <johnscwj@dfw.wa.gov>,

"McCartney, Cheryl" <mccarcam@dfw.wa.gov>, "McLaughlin, John" <jarmack@comcast.net>, "Muns, Clint" <fishhog211@aol.com>, "Ryan, Kevin D" <kevdryan@earthlink.net>, "Thompson, Walt" <wedell@msn.com>, "Barber, Harry" <hab30a@netzero.net>, "Beth Spelsberg" <bspelsberg@comcast.net>, "Bob Reid" <cpr-fish@toledotel.com>, "Boynton, Hal" <fishaholic9@juno.com>, "Burge, Dick" <fskibum@olypen.com>, "Buzz Johnson" <buzzajohnson@comcast.net>, "Conroy, Edward" <aandeconroy@techline.com>, "Dean Oakes" <oakesdean@aol.com>, "Evensen, John" <evensenjc@msn.com>, "Habenicht, Fred" <fishonfred@tenforward.com>, "Hearn, Jim" <unkjim813@msn.com>, "Hoppler, Wes" <hopspot@aol.com>, "Hugh Evans" <hoe@ecl-law.com>, "John Sharf" <jandksharf@aol.com>, "Kelly, John" <jksteel1@comcast.net>, "Lynda Alvarez" <alvarez.l@ghc.org>, "Mantua, Nathan" <mantua@atmos.washington.edu>, "McRoberts, James" <jim4fish@comcast.net>, "Michael Golik" <golikmg@netzero.com>, "Miyawaki, Leland" <miyawaki@iswnet.com>, "Mueller, Dana" <Dana_A_Mueller@rl.gov>, "Paul Opperman" <fish@paul.opperman.net>, "Rhubright, Mike" <MPRhubright@msn.com>, "Sam Ingram" <susanjlam@earthlink.net>, "Schaad Doug" <dcschaad@comcast.net>, "Simonseth, Brian" <homer2handed@hotmail.com>, "Soverel, Pete" <psoverel@wildsalmoncenter.org>, "Tingley, Ron" <ting@fidalgo.net>, "Tucker, Phil" <tuckerps@nas.com>, "Turner, Terry" <tnturner@comcast.net>, "Urabeck Frank" <urabeck@comcast.net>, "Way, Dennis" <denjanway@msn.com>

From: <RRC6633@aol.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/2/2005 5:13:20 PM
Subject: "Official comment to the Cedar River Sockeye Hatchery SEIS"

1 Dear Vikki...I totally support the establishment of a permanent Sockeye hatchery on the Cedar River.

Dick Colman
41515 - 228th Ave. SE
Enumclaw, WA 98022
360-825-4518

DON PETERSON
2120 - 165th PLNE
BELLEVUE WA 98008
MARCH 15 2005

VIKKI ANSELMO
SEATTLE PUBLIC UTILITIES
700 5th AVE, SUITE 4900
PO BOX 34018
SEATTLE WA 98124-4018

SUBJECT: OFFICIAL COMMENT TO THE CEDAR RIVER SOCKEYE HATCHERY SEIS.

1 PLEASE PROCEDE EXPEDITIOUSLY WITH THE SUBJECT CEDAR RIVER SOCKEYE HATCHERY PROJECT. I SEE NO NEGATIVES OF SUBSTANCE BUT HUGE BENEFITS. FULL SPEED AHEAD. PLEASE

RESPECTIVELY

DONALD I. PETERSON

From: "Doug Smith" <dg_smith@msn.com>
To: <Vikki.anselmo@seattle.gov>
Date: 3/11/2005 11:00:11 AM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

1 Dear Ms. Anselmo, I will not be able to the attend the upcoming meeting for the new Hatchery on the Cedar River, but I wish to extend to you my full and hearty support for this project and have supported it for many years. Please vote in favor of this project. It is sorely needed and will have great economic benefits to all of king county and areas surrounding Lake Washington. Sports fishing brings enormous financial returns to the economy. Thanks for your support. Sincerely Douglas G. Smith

Comment Letter DV

Comment Form

Cedar River Sockeye Hatchery Project
Draft Supplemental EIS
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Comments on the Draft EIS must be submitted by 5 p.m. March 21, 2005.

1 Things are in order. Let's move forward & build the hatchery. Let us as a community enjoy sockeye fishing. We the Washington want the hatchery.

Thanks
Don Van Parys

Comment Letter GL

From the Desk of . . .

VIRGINIA I. LODWIG

March 7, 2005

Ms. Vikki Anselmo
Seattle Public Utilities
700 5th Avenue
49th Floor
P O Box 34018
Seattle, WA 98124 - 4018

We strongly support a permanent hatchery for sockeye salmon on the Cedar River. Fishing for the sockeye since 1984 when it was open on Lake Washington for a week or more enabled fishermen to enjoy the thrill of catching the sockeye, but the opportunity to be in a center of a metropolitan area for access and economic benefits.

1 Two Saturdays in 95 degree weather last summer, we were put in a very dangerous situation being on the water in a small boat, kayaks, canoes, etc., while larger or mega yachts on open throttle on both sides causing high rolling waves, with little consideration trying to catch fish, even the fish were on "fast forward" disappearing from the screen.

I get hyped up just going to the Locks to see the fish ladder in July for the sockeye fishing.

Please accept our approval for the hatchery.

Ginny Lodwig
Mike Lodwig
Bob Lodwig

Ginny Lodwig

Comment Letter GM

From: deana peterson <deana98204@yahoo.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/13/2005 1:39:53 PM

1 I support you 100 % in the idea of a new hatchery in the Cedar River area.

A permanent hatchery IS a good idea for this area. A permanent hatchery will create great fishing opportunities for families and a greater economical revenue for local businesses in the area. A permanent hatchery will also help with the population of and take the stress off the wild sockeye in the area. A permanent hatchery will also help guarantee the Indians of this land the opportunity to provide for their families with the abundance of fish that will be available.

Gary McGrew

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Comment Letter GO

From: <GO1SALMON@aol.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/4/2005 12:50:17 PM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

1 This is to document my support for construction and operation of the proposed permanent Sockeye hatchery on the Cedar River. This is a one time opportunity to provide a unique, long term, recreational opportunity to the citizens of this state.

Comment Letter GP

From: "Gayle Powell" <gpowell@wrightrunstad.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/10/2005 4:52:52 PM
Subject: "Official comment to the Cedar River Sockeye Hatchery SEIS."

1 My husband, Jeffrey Powell and I strongly support the construction of the permanent sockeye hatchery on the Cedar River.

Gayle Powell

Property Manager

Wright Runstad & Company

206 328-7627 (main)

206-328-7780 (fax)

Comment Letter JG

From: "rabbey.1@juno.com" <rabbey.1@juno.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/10/2005 3:31:54 PM
Subject: Official commnet to the Cedar River Sockeye Hatchery SEIS

1 I am a sports fisherman and am in full support of the replacement hatchery on the Cedar River.

Thank you,
James A. Guess
28020-201st Ave.S.E.
Kent, Wa 98042

Comment Letter JJ

From: <golfingurlie88@aol.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/14/2005 10:17:16 AM
Subject: Lake Washington Sockeye Fishery

DEAR VIKKI,
1 I JUST WANTED TO LET YOU KNOW THAT MY FAMILY AND I ARE IN FULL SUPPORT OF THE FISH HATCHERY. WE ARE SORRY WE WERE NOT ABLE TO ATTEND THE MEETING THURSDAY NIGHT- WE HOPE IT WENT WELL. THANK YOU.
SINCERELY-
JIM, JILL, & CASSIE GUESS

Comment Letter JK

From: "John Kelly" <jksteel1@comcast.net>
To: <vikki.anselmo@seattle.gov>
Date: 3/14/2005 7:44:25 PM
Subject: Official Comment to the Cedar River Sockeye Hatchery SEIS

Ms. Anselmo,

1 I wish to make known my strong support for the proposed, Cedar River Sockeye Hatchery project. This hatchery, when made operational, will provide unique, fishery opportunities for fishermen and families, especially in the King County region. Past years, with the current hatchery, have sustantiated the public's enthusiam for such a Sockeye fishery that is easily accessable to the public. In addition to the public fishery, there are considerable economic opportunities for related businesses.

I have lived in the Seattle area for 57 years and have been retired 19 years. Fishing is a major recreational interest, having fished since I was 9 years old. I have been a member of the Washington Dept. of Fish & Wildlife, Steelhead Advisory Group for over 15 years, served as: Steelhead Chairman and Director for the Wash. State Sportsmens Council; Past President for the King County Outdoor Sports Council and The Steelhead Trout Club of Washington; and presently serve as Director of the Salmonid Foundation and Director of the King County Outdoor Sports Council.

Thank you for this opportunity to offer comments regarding this Sockeye hatchery project that can provide outstanding recreational fishing opportunities, especially for sportsfishers and families in the King County area.

John D. Kelly
17623 1st Ave S. Apt.125
Normandy Park, WA. 98148
Ph. (206) 243-4402

Comment Letter JM

Vicki Anseimo
Seattle Public Utilities
700 5th Ave.
Seattle, Wa.

Dear Ms. Anseimo:

Re: Cedar River Sockeye enhancement project

In 1989, there was a great deal of effort given to develop ESB 5156 to enhance the Cedar River Sockeye run. This was passed by a vote of 46 to 1 in the Senate and 95 to 0 in the House.

My understanding of the bill was that the enhancement program was to be completed in 1991.
1 The completion of this project seems long overdue.

The hope of bringing back the most significant salmon fishery in the state is worth pursuing. I urge all who have a voice in the development of this project to proceed. There is even more need now than ever to develop a better fishery.

Best wishes for productive decisions.

Jack Metcalf

Jack Metcalf
Wa. St. Senate, retired
U.S. Congress, retired
March 10, 2005
360-221-3822
norma29@whidbey.com

Comment Letter JO

From: "John Snyder" <johns@velectric.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/7/2005 7:37:19 AM
Subject: FW:

> -----Original Message-----
> From: John Snyder
> Sent: Monday, March 07, 2005 6:51 AM
> To: 'Vikki.Anselmo@seattle.go'
> Subject:
>
> I have been fishing Lake Washington for Sockeye, since 1959 when my Uncles taught me how to fish with spoonsn and I have been fishing it ever since. I cannot believe that we have such a big fishery, right in our Cities back yard. This has to be a big boost to the economy, as well. This run was planted in 1932,
1 by the University of Washington, so is not even considered a native run to the area.Enhancing it to be a yearly fishery would be a big bonus to city and state. You don't know how many people I know, that start wondering if we have a season, every year. We start talking about it in January. I am very much for installing the permanent hatchery on the Cedar River.
>
> Thank You for your time,
>
> John Snyder
> General Foreman
> Valley Electric
> University of Washington DG Bus Replacement Project
>
> Cell # 206-852-8390
>

JAY RUSLING
4235 91ST AVE. NE
YARROW POINT, WA 98004-1211

3/13/05

Vicki Anselmo
Seattle Public Utilities
700 5th Ave
Seattle, WA 98124-4018

SUBJECT: Cedar River Sockeye Hatchery SEIS

Dear Ms Anselmo:

1 It is of the utmost importance that this SEIS be approved immediately. Our State Legislature responded magnificently in 1989 by overwhelming passage of ESB 5156. With our sports salmon opportunities in precipitous decline, this offered an excellent chance to preserve some of our priceless Northwest heritage of having opportunities for sports angling for salmon.

Our State Legislature envisioned the enhancement project to be completed in 1991. The legislative intent, which was highly in the public interest, has been thwarted by numerous delays. Further postponement of construction of the hatchery will only result in continued loss of opportunity to the public.

Very Truly Yours,

Jay Rusling

Jay Rusling

Member of Six Man Policy
Committee Mandated by ESB 5156

From: "J.M.Williamson" <haggis@whidbey.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/8/2005 9:13:25 PM
Subject: Official Comment to the Cedar River Sockeye Hatchery SEIS

Vikki,

1 I am unable to go to the March 10 th Public Meeting .
Please take and convey my support for the new replacement Cedar River Sockeye Hatchery.
This is so important to myself and my family and sport persons utilizing this wonderful Pacific Northwest Tradition, Lake Washington Fishery.
With this Supplemental Hatchery Fishery we share our beautiful North West with so many and keep with its rich bounty special to us in this region. Please help us to get it up and running quickly.

Thank You John Williamson

Comment Letter KF

From: "Ken Fortune" <Ken.Fortune@swedish.org>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/9/2005 11:01:05 AM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

1 Please register my support for a permanent new Cedar River sockeye hatchery. I am an avid angler and love sockeye fishing in Lake Washington. I have enjoyed the last couple of years and so have my Grandchildren (4) that have enjoyed the wonderful fishery that the temporary hatchery has provided. I can't imagine not seeing the sockeye come through the Ballard Locks.

Ken Fortune
Director of Logistics
Supply Chain Administration Division
(206) 386-6185
(206) 405-6827 Pager
(206) 386-2199 Fax

CC: <Steve@Lwproperties.com>

Comment Letter KM

From: "Kelli Thress" <kthress@msn.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/13/2005 7:23:38 PM
Subject: Official comment to the Cedar River Sockey Hatchery SEIS

Dear Ms. Anselmo

1 I fully support the proposed sockeye salmon hatchery on the Cedar River. I have lived in the Seattle area my entire life (35 yrs), and cannot think of a recreational sporting event that can compare with the Lake Washington sockeye fishery.

This fishery has been a monumental yearly event in my growing up in the Seattle area. Throughout my childhood years I can recall the glorious experiences I've had during the yearly sockeye fishing season in Lake Washington. I even more cherish the occasional fishery we have been privileged to experience in recent years.

This fishery, receiving the publicity it does, could likely be the leading sales generator for our local sporting good retailers and also strongly supports the local parks with boat launch fees since launching opportunities are limited on the lake.

Thank you for taking the time to read my input on this subject.

Kelli Mack

Bellevue, WA

Comment Letter LA

From: "llabbey@juno.com" <llabbey@juno.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/10/2005 3:41:27 PM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

1 I am a sport fisherman and am in support of the replacement hatchery on the Cedar River.

Thank you,
Laurie Abbey
19822-122nd St. E.
Sumner, WA 98390

Comment Letter LE

From: "Lisa Eckhart" <LisaEckhart@aaawin.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/10/2005 1:24:28 PM
Subject: Official Support of the Cedar River Sockeye Salmon Hatchery SEIS

1 My husband and I fish and the experience and outright enjoyment of being on the water and trying to catch them is exciting!
The better opportunity to catch them with more being raised is vitally important to the future of this recreation for the sportsman and everyone out there.

Sincerely,

Lisa Eckhart, CTC
AAA Travel Agency
4554 9th Ave. N. E. Ste. 120
Seattle, WA 98105
206-548-7801
1-800-303-2465
LisaEckhart@aaawin.com

Comment Form

Cedar River Sockeye Hatchery Project
Draft Supplemental EIS
Public Hearing, March 10, 2005, 7:00 to 9:30 pm

Please provide us with your comments on the Draft Supplemental Environmental Impact Statement (EIS) for the Cedar River Sockeye Hatchery Project. You can complete this form and leave it in the box provided or mail to the address on the back. In addition, you can email your comments to vikki.anselmo@seattle.gov. Please state in the subject line "Official comment to the Cedar River Sockeye SEIS."

Comments on the Draft EIS must be submitted by 5 p.m. March 21, 2005.

I have lived in Seattle all my life, but it wasn't until I met & married my husband Brian Lull that I fell in love with fishing too! There seem to be many conflicting issues when it comes to salmon conservation, but as many of us here believe, it is a matter that requires development in order to maintain the natural resource.

1 There are not only socioeconomic benefits to protecting / achieving this sockeye hatchery, but the values past down from generation to generation. Clearly, this too is a value that should be maintained and passing it on is an experience that cannot have nor should have a limitation.

Thank you,
Gina Lull

Comment Form

Cedar River Sockeye Hatchery Project
Draft Supplemental EIS
Public Hearing, March 10, 2005, 7:00 to 9:30 pm

Please provide us with your comments on the Draft Supplemental Environmental Impact Statement (EIS) for the Cedar River Sockeye Hatchery Project. You can complete this form and leave it in the box provided or mail to the address on the back. In addition, you can email your comments to vikki.anselmo@seattle.gov. Please state in the subject line "Official comment to the Cedar River Sockeye SEIS."

Comments on the Draft EIS must be submitted by 5 p.m. March 21, 2005.

1 LK WA SOCKEYE ARE A HUMAN MANUFACTURED RUN .. THEY SHOULD BE MANAGED FOR HUMAN CONSUMPTION.

BRIAN LULL
FISHING + HUNTING NEWS ADVERTISING REPRESENTATIVE
MID-SOUND FISHERIES ENHANCEMENT BOARD MEMBER

From: "Larry Walsh" <LandDWalsh@winisp.net>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/15/2005 9:26:05 AM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

1 I strongly support the permanent hatchery on the Cedar River. I have fished every opportunity for sockeye since they started opening it, and I think it the greatest thing since sliced bread to have a fishery like this in an urban place like Seattle. Simply fantastic!!!

Larry Walsh
6305 121 Ave SE
Bellevue WA 98006
425-747-6795

8.

In the world of fisheries management, decision makers risk being overwhelmed by various competing interests. To deal with the blizzard of decisions that must be made, their focus becomes ever sharper upon immediate concerns, but they sometimes lose sight of issues affecting generations to come. In other words, attention spans shorten, horizons get closer, and vision becomes myopic. I'd like to take this opportunity to bring just three things into sharp focus for this group: solid science, economics, and people.

1 I know I'm not smart enough to be an expert in all matters pertaining to hatcheries. That's why I'm pleased that Seattle recruited some of the best minds in fisheries science to develop the Supplemental EIS for the Cedar River permanent sockeye hatchery. These experts, some of whom have loudly criticized poorly designed hatcheries, found no adverse impacts to the watershed's fish or environment. This world-class facility, designed with the latest technologies and research, doesn't just avoid the pitfalls of older hatcheries. The solid science and careful management that are its underpinnings will actually benefit wild salmon, such as ESA-listed Lake Washington Chinook.

2 Our last two openers for Lake Washington sockeye in 2002 and 2004, though painfully brief, generated (according to estimates from WDFW figures) approximately $1,000,000 a day in sports fishing gear, gas, licenses, etc. These fisheries would not have happened without the temporary hatchery's supplementation of the natural run. Hatchery fish made up almost a quarter of those returns. Clearly, an investment into a regularly recurring fishery of this magnitude would pump much-needed revenue into the area's economy.

3 I stay involved with my local Boy Scout troop, even though my son earned his Eagle rank eight years ago. The boys' favorite outing of the entire year is the fishing outing. With the donated help of professional guides, the scouts angle for salmon or steelhead. We typically drive 2 to 3 hours from Renton to get to the fishing spot. The boys sometimes ask if it's possible to catch salmon in Lake Washington and my answer is always, "Maybe someday. Maybe someday."

This is an historic opportunity for policy makers to say "Yes." There are no losers here. Our best scientists say this is good. Our economists say this is good. The people in this room, representing generations of eager fishers to come, say this is good. Please act to seize this opportunity. Build this permanent hatchery.

Thanks you,

Joseph Madrano
18605 – 106th Pl. SE
Renton, WA 98055
425-277-3942

Comment Letter MC

From: "Gregory McPherson" <seattlegmac@msn.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/12/2005 5:51:25 PM
Subject: Official Comment to the Cedar River Sockeye Hachery SEIS

Vikki,

1 Being a life long Puget Sound resident, 49 years, I am in favor of the hatchery. I fished the sockeye in the lake with my Father in the 60s and he fished it with me in the 90s and I want to fish it with my son's in the future.

Thank You
Greg McPherson

Comment Letter MK

From: "Martin Kasischke" <rejoicing@comcast.net>
To: <vikki.anselmo@seattle.gov>
Date: 3/5/2005 9:40:58 AM
Subject: Official Comment to the Cedar River Sockeye Hatchery SEIS

1 Opponents of the proposed Cedar River hatchery claim introduction of non-native Sockeye to the Cedar will have deleterious effect on native stock. The long history of hatchery produced salmon in this area leaves considerable doubt about the existence of any truly native fish in the watershed. The preponderance of damage to the native salmon population was accomplished over history by human development and carelessness. It is unlikely that process will be reversed anytime in the foreseeable future. The proposed hatchery will mitigate such damage and provide some hope for recovery of the salmon population. That is not the case without the proposed hatchery.

2 The overwhelming benefits to the salmon population of Lake Washington, the Seattle/King County economy, the enjoyment of sportsman in the northwest and re-establishment of ecological balance significantly outweigh the questionable concerns of critics of the proposed Cedar River hatchery. It is in the best interests of this area that the Cedar River hatchery project be completed.

Martin Kasischke
6876 83rd Ave SE
Mercer Island, WA 98040

Comment Letter ML

Vikki Anselmo - Official comment to the cedar river sockeye hatchery SEIS

From: "mike lindbo" <mikelindbo@hotmail.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/9/2005 7:32:20 PM
Subject: Official comment to the cedar river sockeye hatchery SEIS

1 I want to give my support to the plans for a hatchery on the Cedar River for the Sockeye. My parents introduced me to this fishery about 25 years ago and have been hooked ever since. It ends up being the only local opportunity alot of us have at a fun productive salmon fishery. I know that I also speak for at least 40 other relatives and friends that have enjoyed this fishery and have wished that the seasons could be longer and more frequent, like it used to be in the and 80's. This topic always comes up at our family reunions and is supported by all.

If you would like emails from all of my family and friends that have enjoyed this fishery I would be happy to have them send their support as well for this proposed hatchery. Thank You.

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Comment Letter MM

From: <Momunchjo@aol.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/10/2005 3:40:27 PM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

1 I heartily support the construction of a permanent Sockeye Salmon hatchery on the Cedar River. A consistently strong run of sockeye salmon, year after year, would be beneficial to sport fisherman as well as Indian commercial fisherman and the economy of Washing ton as a whole. It is time to quit talking about this cost effective facility and to begin construction.

Sincerely,

Maurice Munch
21231 SE 248th St.
Maple Valley, WA 98038

425-432-1498
momunchjo@aol.com

Comment Letter MS

From: Vikki Anselmo
To: "mlsipin@comcast.net".SEAGOV1.RES04
Date: 3/21/2005 7:59:00 AM
Subject: Re: CEDAR RIVER

Attached is the draft SEIS for your review.

Vikki Anselmo
Seattle Public Utilities
Director's Office
(206) 684-5851 Main
(206) 386-4560 Direct

>>> "michael sipin" <mlsipin@comcast.net> 3/19/2005 9:46:01 PM >>>

1 THANK YOU FOR HELPING WITH THE CEDAR RIVER.
IF POSABLE PLEASE SEND ANY INFO ABOUT THIS ISSUE TO ME.
AFTER 30 YEARS LIVING ON THIS RIVER, ITS ABOUT TIME SOMETHING MAY BE DONE RIGHT.
MICHAEL SIPIN 206-909-6069

Comment Letter PF

From: <Pfeiflemc@aol.com>
To: <vikki.anselmo@seattle.gov>
Date: 2/28/2005 12:48:36 PM
Subject: official comment to the cedar river sockeye hatchery

1 please count me on the list for a soskeye hatchery on the cedar river . this is long overdo

Comment Letter PH

From: <PhoenixNSeattle@aol.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/5/2005 6:39:31 PM
Subject: "Official comment to the Cedar Ri ver Sockeye Hatchery SEIS."

1 I am sending this letter to let you know I support the new Cedar River sockeye hatchery. Like many others in the area, I recognize the need for such improvements.

I am asking you to also support this hatchery.

Phoenix
A Renton resident

Comment Letter PL

From: "Phil & Sandy Lyons" <p.s.lyons@comcast.net>
To: "Vikki Anselmo" <Vikki.Anselmo@seattle.gov>
Date: 3/6/2005 1:06:34 PM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

1 I am a sports angler that supports the building of the new Cedar River Sockeye Hatchery. I am also a senior, and I am hoping that my grandchildren will have an opportunity to fish for these salmon in Lake Washington.This will also be a boost for Seattle's economy and the fishing community. Please support this important project.

Thank you
Phil Lyons
Puget Sound Anglers

Comment Letter PW

From: "David Powell" <fish.doc@verizon.net>
To: <vikki.anselmo@seattle.gov>
Date: 3/14/2005 11:11:02 AM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

Dear committee members,

1 I strongly support the building of the Cedar River Sockeye Hatchery.

As a PhD in Fisheries (1989), my reading of the Draft Supplement (Feb 05) has revealed that this facility will not significantly impact other runs of protected salmon. This facility will divert fishing pressure and predation off protected fish and in the long run, benefit the sustained population growth of other fish (Chinook, Bear Creek fish, etc). The potential problems of domestication, genetic diversity or predation seem greatly overstated by critics to this plan. Straying and cross breeding with other stocks of fish has never been shown to have any long lasting detrimental effects on wild fish. In fact, the injection of reproductively active fish from different fish often results in a beneficial hybrid vigor effect with genetically superior offspring. In this way inbreeding suppression is avoided and diversity is actually increased.

2 Hatchery produced fish are only manipulated during a very short period of their life and provide an important supplement to wild populations by protecting year classes of fish from such things as naturally occuring random flooding events and fungal infections. Our experience with the spawning channel clearly demonstrates the great benefits such additions can be to the sockeye population.

3 In summary, the sooner this facility is constructed, the sooner we will be able to reliably sustain an increased population of Sockeye.

Sincerely,

David B. Powell, Ph.D.

Vice President of Research
ProFishent, Inc.
(425) 883-9896

CC: "Elliott, Richard" <richelliott@DWT.com>

Comment Letter RA

From: "rabbey.1@juno.com" <rabbey.1@juno.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/10/2005 3:34:53 PM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

1 I am a sport fisherman and I support the replacement hatchery on the Cedar River.

Thank you,
Robert Abbbey
19822-122nd St. E.
Sumner, WA 98390

Comment Letter RC

From: <Raythepiper@aol.com>
To: <Vikki.anselmo@seattle.gov.>
Date: 3/10/2005 2:20:13 PM
Subject: Official comment to the Cedar River sockeye hatchery

1 I would like to add my name to those favoring building a new Cedar River sockeye hatchery.

Ray Colby
PO box 2058
Lynnwood, Wa 98036

Comment Letter RD

From: "Rory Diessner" <roryfd@hotmail.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/4/2005 6:02:21 PM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

1 I highly support the new Sockeye Hatchery on the Cedar River. I feel the new Hatchery will increase the sport fisheries and add an economic boost by the sport fisherman fishing for those fish. It will also give my chidlren a better chance to fish for Sockeye as they grow up.

Thanks
Rory Diessner
Milton, WA

Comment Letter RE

From: "Elliott, Richard" <richelliott@DWT.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/14/2005 3:51:59 PM
Subject: Cedar River Sockeye Hatchery

Dear Committee Members:

1 I strongly support approval of the Cedar River Sockeye Hatchery. I am an environmental lawyer and my wife is a Ph.D. fish disease research scientist. I am also a member of Puget Sound Anglers. Establishment of the hatchery will take fishing pressure off wild salmon stocks, including ESA-listed fish. The opponents have failed to prove their case. Best available science supports moving ahead with this important project. The environmental impacts are minimal and likely positive. There has been more than enough study and process. The time to act is now.

Thank you,
Richard W. Elliott

Sent from my BlackBerry Wireless Handheld

Comment Letter RH

From: "russ heagle" <seaeagle_2@hotmail.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/10/2005 6:34:40 AM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

1 I would like to let you know I support the new Cedar River sockeye hatchery. It will open an excellent recreational opportunity for Seattle area sportsmen, and will provide an economic boost to area businesses. It will provide future fishing so my 12 year old son will be able to take his kids fishing in the future, and be able to share the experience with them, not just have a one time child hood memory of sockeye fishing on Lake Washington.
thank you very much,
russ heagle

Comment Letter RK

From: "Rich Kato" <rkato@farwestsports.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/10/2005 10:08:33 AM
Subject: Official comment to thje Cedar river sockeye Hatchery SEIS

Good morning,
1 The sockeye hatchery for Lake Washington generates revenue for everyone: sporting goods stores, local service stations, especially the city of Seattle and the state of Washington in much needed tax revenues. This is the only fishery in reach of thousands of local anglers including children-what a great way for them to spend a weekend -fishing in the summer close to home, catching salmon and doing this as a family outing. A sockeye hatchery would be a win-win situation for everyone. It would provide recreation for everyone interested, much needed revenues, a long term fishery, more utilzation of Lake Washington, local jobs, and tourism. We need to make Washington the salmon capital of the world like it used to be. After all, the salmon is the icon of the Northwest and you are the one that can get the ball rolling. Thank you/rich kato

Comment Letter RY

From: "Ray Ashmun" <rayashmun@comcast.net>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/9/2005 9:12:07 PM
Subject: official comment to the Cedar River Sockeye Hatchery SEIS

1 I can not attend the public meeting tomorrow evening at Renton Technical College so I hope you will accept my email. My family is strongly supportive of having a sockeye hatchery on the Cedar River. We think it is hurtful to even consider not having the hatchery open. Sockeye fishing on Lake Washington is one of the family events we look forward to. It is how we can easily (and cheaply) introduce the grandkids to salmon fishing. Please do your best to keep the Cedar River hatchery open.
Thank you,
Ray Ashmun

From: "Awad, Sherif J [PVTC]" <sherif.j.awad@smithbarney.com>
To: "'Vikki.Anselmo@seattle.gov'" <Vikki.Anselmo@seattle.gov>
Date: 3/4/2005 10:47:02 AM
Subject: "Official comment to the Cedar River Sockeye Hatchery SEIS."

1 A sockeye salmon hatchery on the Cedar would provide a huge economic benefit for our state!

"The highest compliment I can receive is the referral of your friends, family and business associates. Thank you for your trust."

Sherif J. Awad
Portfolio Manager - Financial Consultant
Financial Planning Specialist

Smith Barney
A Division of Citigroup Global Markets, Inc.
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From: "Mike Stefanick" <mstefanick@connectexpress.com>
To: "Vikki Anselmo" <vikki.anselmo@seattle.gov>
Date: 3/10/2005 11:10:40 PM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

Seattle Public Utilities: Regarding the proposed Cedar River Sockeye hatchery, I want to tell you that it must be done: construct, operate, maintain and produce millions of sockeye salmon. It will yield a fishery in Lake Washington that will be beneficial on many levels.

My reasons for doing so are simple and straight forward:

1 1). The economic benefits of a sockeye fishery in Lake Washington are enormous. Many local dollars are spent in pursuit of fishing tackle, boat operation, and assorted activities that go with this recreational fishery. It is also a tourist draw, as my relatives, and others I know, have visited specifically for sockeye fishing.

2 2). The social and cultural benefits of a sockeye fishery contribute greatly to the livability and pride of Seattle and the NW. There are few fishing experiences that the whole family can enjoy with minimal equipment. Lake Washington is gentle enough that many types of water craft--from a small row boat to cruiser-- can participate in the fishery. The salmon is one of the great symbols of the Pacific Northwest, with the hatchery you have the opportunity to enhance a fishery to the point where it will become even more widely recognized and enjoyed, as well as marveled at. Imagine being able to "brag" about a fishery nearly at the footsteps of downtown!

3 3). The science of the proposed hatchery assures that this strain of "imported" sockeye salmon from Baker Lake will continue to be a viable and significant contribution to the fishery of the NW. The developmental scientific work that has been done via the temporary hatchery insures that this project will be copied elsewhere. The random collecting of brood stock in the lower river and raising them to fry for release back to the natural environment eliminates the creation of a "hatchery fish." The gene pool remains intact and wild. The proposal to monitor, evaluate and adjust as an operational procedure ought to guarantee even better production methods as the project matures.

4 4). Lastly, I want to sting. The Mariners and Seahawks got stadiums inspite of a vote by the people against those projects. The amount of money needed for this project is nowhere near what those sports palaces cost. The hatchery will produce no sockeye that will require a multimillion dollar signing bonus, nor will any of them require 10 digit on going salaries. Find the political will to do a project that regular folks can enjoy and afford, and that this grandfather can teach his grand kids the joys of fishing.

Respectfully,

Mike Stefanick.

Comment Letter TJ

From: "Tim Johnson" <tjohnson@nwcomposites.com>
To: <vikki.anselmo@seattle.gov>
Date: 3/10/2005 10:37:40 AM
Subject: Official comment to the Cedar River Sockeye Hatchery SEIS

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To whom it may concern:

1 I am voicing my support for the new proposed sockeye hatchery on the cedar river. This would guarantee that we would have more predictable fisheries and would possibly make this sockeye fishery more enjoyable. The fishery as it is today is for too few fish and the openings are typically 1 to 4 days which jams everybody on the lake all at the same time. I have fished this sockeye fishery and sure is alot of fun. I have taken my two daughters and they had a blast catching sockeye on a flat calm lake enjoying the sunshine in July.

I think it would be a tragedy if this does not happen. As we continue to have our outdooor activities taken away as we see shrinking seasons on crab, salmon, bottomfish etc. This would be an opportunity to extend or make more predictable an awesome fishery.
Best Regards

Tim Johnson
Program Manager
Northwest Composites
(360)530-1534
tjohnson@nwcomposites.com

Comment Letter TL

From: "Tom LaPlant" <tlaplant@comcast.net>
To: <vikki.anselmo@seattle.gov>
Date: 3/8/2005 8:25:08 PM
Subject: Official Comment to the Cedar River Sockeye Hatchery SEIS

Dear Ms. Anselmo,

I want to request your support for the new Cedar River Sockeye Hatchery.

1 I grew up on and currently live on Mercer Island, and have had many fun fishing experiences on Lake Washington. This past summer, for the first time, I was able to take my three children Sockeye fishing. We caught one Sockeye and it was a terrific experience for my children. I would like those experiences to continue in the future.

We live on the waterfront and we had Sockeye spawning and dying on our beach. It was a wonderful learning experience for my children. Eagles and other birds were feeding on the fish which helps the foodchain. This also was a learning experience to watch the cycle of nature.

2 There is a large financial benefit to the economy through fishing licenses, boat licenses, fishing tackle, fish depth finders, trolling motors, boats, boat gas, etc. For instance, I went out and bought three set of fishing poles, reels, hooks, weights, etc. Based on the number of boats on Lake Washington on the days that Sockeye fishing was open, the financial impact to the economy must be enormous. Many of those purchases would not be made in the future if there is no Sockeye season on Lake Washington.

Please support the new Cedar River Sockeye Hatchery.

Thank you.

Tom LaPlant

(206) 947-1480

14 Meadow Lane

Mercer Island, WA 98040

From: "jimwright_1@netzero.com" <jimwright_1@netzero.com>
To: <Vikki.Anselmo@seattle.gov>
Date: 3/4/2005 1:33:06 PM
Subject: Official comment to the Cedar River Sockeye Hatchery

1 Hello my name is Jim Wright, I have Wings to Tails taxidermy and I recently found out that the cedar rr hatchery was being considered to close. As a small business owner I would like to ask that it be reconsidered the fishing opportunities are being so restricted, and the runs so dwindled that its not going to just affect fishing, but my lively hood as well as others, who rely on fish being caught to make a living. plus not to mention the revenue that the fish bring in to Seattle, if there is no fish there is no fishermen. Thank you for your time. If you have any questions please fell free to call. And Please keep the hatchery going .

Jim Wright
Wings to Tails Taxidermy
(360) 769-7473
jimwright_1@netzero.com

Public Hearing Transcript and Responses

Cedar River Sockeye Hatchery
SEIS Public Hearing
March 10, 2005

The following comments were summarized from notes taken by SPU staff and consultants at the public hearing. These comment summaries do not represent a transcription of the comments.

1 **1. Reagan Dunn: KC Councilmember**
Newly appointed King County Councilmember, but he's talking tonight as a private citizen. He's strongly supportive of the Hatchery project. He grew up in this area; grew up fishing and it's important to him to join in to voice support for the project proposal. He sees that there are a lot of benefits to moving forward with the project: fishing is a great benefit to families and our economy; it adds a positive element to our lives; it's exciting to have a sockeye fishery. Now is the time to move. The production capacity of the existing facility is 50% of what it could be. He commends folks on their work on the report. Seems like there are low impacts on all the issues of concern. If there are problems, there are corrective measures. It's good to have lots of sockeye coming back. He looks forward to working with everyone to make this project happen.

2 **2. Andrew Ewing**
He has been fishing since he was 8 years old. He would like to have his family have the same opportunity that he had to fish. He thinks the hatchery should be built.

3 **3. Bruce Blevin**
The new process that's explained in the SEIS allows people to back up if needed; it's good to have this ability. It's good to have young people involved in supporting the project. He's glad to see this project come about.

4 **4. Tom Pollack**
He's a lifetime resident of Seattle and tied in to the fishing industry. He's impressed with what he's seen in the project. Been in the tackle business since the late 50's. Fishing brings families together as a unit. The commodity is well protected. He used the analogy of a sports team – preseason forecast looks good, but really how good of a chance do we have? The counts of fish are escalating and the fishing community is a buzz with the possibilities of having a season. This creates a lot of excitement. Outmigration was good; we could have a better season if the hatchery is in place.

5 **5. Milt Kaiser**
He's making comments on behalf of the Eastside Steelheaders and Mt. Si Fish & Game, plus he's a member of NOWA. He's been chasing sockeye for a long time and he's been a long time advocate to have a good return of sockeye every year. Half a million sockeye could mean half a million dollars to the economy for the Seattle area; new boats, trucks, hitches, trailers, etc. On a personal level, he feels that families will come to visit the area to contribute to the economy from other areas of the country. This can be a big thing for our area; we have a jewel of a lake next to Seattle.

6 **6. Bill McKay**
He has been in this process of working towards a hatchery since 1989; got the law passed. Being involved this long, he's been to a lot of meetings and hearings. He commented on the fine SEIS document and commended the amount of effort to incorporate the lessons learned from the temporary hatchery. The finest scientists have been involved. We have the science on our side. The economics also shows that the project should proceed.

7 **7. Ann Adams**
She has reviewed the study. It is very good and quite thorough. It's time to build the hatchery.

8 **8. Joseph Madrano**
He recognized the competing interests. The issues are immediate and myopic. We should focus on solid science, economics, and people. Experts found no adverse impacts and some of these experts have been critics. The new facilities will have benefit to the species in the lake. The fishery generated close to $1 million per day. This would not have happened without supplementation to the natural run. The investment would pump dollars into the economy. He also talked about his experience with the Boy Scouts having a fishing outing every year in which they had to drive 2 to 3 hours away to fish. This is a historic opportunity for decision-making to support sports fishers.

9 **9. Larry Stanley**
He is talking as a representative from the Sno-King Chapter of Puget Sound Anglers. They voice their support (about 150 people) for the hatchery. The possibility of a fishery made quite a buzz of excitement; it brings the group together including kids, grandfathers, ladies, etc. This fishery is exciting to people. One story that was told to him was about a family reunion where four generations were able to go out fishing together and have a great experience. Everybody is out there on the lake when there is a fishery; there's a lot of variety of people and crafts. Now is the time to have a dependable fishery. Economically it can't fail. There is a lot of science that has gone into the development of the hatchery project.

10 **10. Debra Stevens**
She grew up on Lake Washington and has fished for salmon all her life. She takes her family and friends to fish too (17 people on a couple of sockeye fishing days). Any kind of boats and gear will do. This is a local tradition that improves community morale. This is lots of fun and it's more than just a fishery and a season. People go to a lot of effort because it is special. This fishery is a good example of what a hatchery can create. It doesn't seem to her that there are adverse impacts. She hopes that the project is built and there's no more delay so that we can give people first hand participation.

11 **11. Carl and Irene Carver**
As a lifetime resident of Washington, a registered and active voter, a family man and active and involved sportsman I would like to provide my input into the feedback process for the cedar river hatchery. First of all I want to say that based on the scientific information that I have read carefully and what I know myself about fish and hatcheries it is overwhelmingly clear that the hatchery project should proceed immediately with no further delays. It really concerns me when a few individuals can affect the outcome of something so important and stall it with minimal

scientific information. It concerns me as well that those who are in the decision making process do not use common sense and good judgement to stop those who are in the significant minority on this hatchery project. I have worked on many habitat and fish restoration projects in Washington and do so to put back into the resource what me, my family and friends appreciate and enjoy so much. We enjoy the Lake Washington fishery and the opportunity to participate in the Sockeye fishery. There is no doubt that we will have a significantly improved fishery as a result of a new and improved hatchery on the Cedar River. It will provide opportunity and continue a way of life in our community that we all live for as residents of Washinton.

11 I want to make it clear that this is an important issue for me and my family as sport fishermen/women and lifetime residents of Washington. I strongly urge you to proceed in an expeditious way with getting the hatchery project started and completed so that there is not a continued waste and impact on our fishery. Myself and my family are available to support you with this project at any time. Please call and we will be there like we are for many other habitat and community projects here in our home state of Washington. We are proud of our state and want to continue to improve and support important projects which benefit all the residents of our state. Your support with my request is appreciated! 18912 SE 318th Place Auburn Washington 98092 Phone: 253-630-3184

IN RE:)
CEDAR RIVER SOCKEYE HATCHERY PROJECT)
DRAFT SUPPLEMENTAL EIS,)

TRANSCRIPT OF PROCEEDINGS

7:45 P.M.
MARCH 10, 2005
RENTON TECHNICAL COLLEGE
3000 NE FOURTH STREET
BLENCO AUDITORIUM
RENTON, WASHINGTON

REPORTED BY: KAREN ALIGO, CCR# 2507

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A P P E A R A N C E S

HEARING OFFICER:
JUDITH NOBLE
Seattle Public Utilities
700 Fifth Avenue
Seattle, Washington 98124

ALSO PRESENT: BRUCE BACKER, SPU
LINDA DeBOLDT, SPU
MOLLY ADOLFSON, Adolfson Accounts
WILLIAM FOSTER, Seattle City Attorney's office

P R O C E E D I N G S
RENTON, WASHINGTON; MARCH 10, 2005
7:45 P.M.
--o0o--

12 MR. MUNS: My name is Clint Muns. I'm the director of resource management for the State Board of Puget Sound Anglers, and I'm a member of the South Sound Chapter based in Olympia. I'm here tonight to go on record to let people know that we are in support of this facility. The Lake Washington Sockeye Hatchery has been under consideration for a long time, too long. The science finds no problems. Economics 101 indicates that it would be beneficial to the region. The recreational fishing community has been on bended knee for years.

The philosophical facade that has been undermining this project needs to be ended. We ask the policymakers consider the facts, consider the economic benefits to the region, and consider the recreational benefits and allow this project to proceed now. Thank you.

13 MR. KUPPINGER: My name is Cliff Kuppinger. I'm a native Washingtonian, born and raised in Eastern Washington. Went in the air force in 1948.

And then I came to Western Washington in 1958 when I was taken to court. I have fished since I was a preteen, 11 years old over in Sprague Lake. We didn't have trout or salmon or anything over there. The only thing we had was spiny rays. When I came here, I learned to fish for sockeye and steelhead, and when they had the first sockeye season, I was one of the first ones out there.

13 I think this science that they put together here is the best we can have, and I'm going to take exception from Joe Madrano when he said these people are experts. No, they are not. These people are knowledgeable scientists, not experts. So let's have this hatchery. I enjoy the sockeye fishery, and I hope everybody else does, too. Where else can you have a salmon fishery in your frontyard or backyard. Thank you very much.

MS. NOBLE: If you would spell your last name that will help.

14 MR. WIEST: My name is Harry Wiest, W-I-E-S-T. I'm the president of the South King County Chapter of the Puget Sound Anglers. As president of the chapter, we have about 160 members.

I get asked all the time where is the best opportunity to fish. Unfortunately, most of the time when it comes to salmon, I have to say West Port. I have to say Columbia River. I have to say Neah Bay, Seiku. It's usually not someplace local. We may get a run, a spurt that comes through, and Elliott Bay once in a while. But more often than not, if you ask me the best opportunity to fish for salmon, you're going to drive.

A lot of times that drive is also Canada. It's Oregon. I would love to be able to say the best opportunity is right here in your backyard. It is

14 Lake Washington. Since I was a kid, it's been my favorite fishery. Almost everyone that does fish for sockeye is successful at it.

It would be great to hear people from around the state say, Let's go to Lake Washington to fish, not, Let's go to Canada. Let's go to the coast. When I was a kid, I used to live above the Cedar River. I used to skip school, go down fish for trout fish, fish for steelhead. Of course sometimes I had to explain why I was barbecuing trout instead of doing schoolwork, and my dad would laugh, and he knew what I was doing, but had to hide it from mom.

But that opportunity doesn't exist anymore.

14 Can't fish for steelhead in the Cedar River anymore. They are not there. We can't fish for trout. They had a limited catch and release season this year. I don't know if we'll do that again. But the opportunity when I was a kid that existed does not exist anymore.

I would love for the opportunity to fish for sockeye to appear every single year. I would have no greater feeling than to not wonder if there's a sockeye season but know there's going to be and for everyone to count on it. Thank you.

MS. NOBLE: Well, I would like to welcome Larry Fisher from WDFW that's come in. I've neglected to note that, and Bruce has just reminded me. Thank you for coming.

15 MR. STEFANICK: My name is Mike Stefanick, S-T-E-F-A-N-I-C-K. I thought I was being pretty creative and came up with all the same reasons that all the rest of you guys have come up with. So I won't bore you with them all. I wanted to speak to the economic benefits of the sockeye fishery, the social and cultural benefits as well as the great science that appears to be well bedded in this

project.

The one thing I do want to lastly make comment about, though, is I want to kind of state this area: The Mariners and the Seahawks got stadiums in spite of the vote by the people against those projects. And I don't mean to step on any sports fans on this, but the amount of money needed for this 15 project, that is the new hatchery, is nowhere near what those sports palaces cost. Not even the sockeye will demand a multi-million dollar signing bonus, nor will they require ten-digit ongoing salaries.

I implore the Seattle Public Utilities and the City of Seattle to find the political will to do this project so that this old grandfather can have some opportunity to teach his grandkids the fun of fishing. Thank you.

MS. NOBLE: Mike Harding, followed by Frank Urabeck and Gary Habenicht.

16 MR. HARDING: Good evening, I'm Mike Harding, H-A-R-D-I-N-G, from Snohomish, Washington. I'm part of the Everett Salmon Club. I came down tonight to offer these folks our support of 187 members that said, yes, we would like to have the

16 hatchery. Lots of good memories in our club on the hatchery, and I sure enjoyed myself the last few years. I'm a fisherman, and I say let's get the hatchery and fish. Thank you.

17 MR. URABECK: My name is Frank Urabeck, U-R-A-B-E-C-K. I am using notes because I want to get my comments in within the time frame. I wear a lot of different hats, as you all know, and I'm here tonight to represent the Washington Council of Trout Unlimited for about 5,000 members organization. I'm a retired engineer, civil engineer. I'm a member of the Seattle Public Utilities Anadromous Fish Committee, which has done a lot of the planning with regard to the hatchery. I was involved in technical committees.

Back over 10 years ago we had some good science, and we were trying to decide then do we do a spawning channel, which has been a goal for a long time, as Bill remembers, or to build a hatchery.

He saw the signs evolving. He saw work coming out of Alaska. And after we weighed the pluses and the minuses, we concluded the hatchery would be the best way to go, and then there was a lot more work. Again, it's been mentioned tonight, we've had the benefit of 14 years of that temporary hatchery.

17 We not only had the benefits with the fisheries in the lake, but we gathered an awful lot of information. Those fish were marked, and we can evaluate their returns and their performance.

So I want to point out that there has been a lot of good science by a lot of people over a long period of time. I don't know of any other hatchery facility in the state of Washington that has ever received this kind of attention.

Now, my involvement with Cedar is again both personal. I have fished Lake Washington for over 40 years for sockeye and professionally. I was with the Army Corps of Engineers for 30-something years and had the opportunity to do some work with the City of Seattle involving controlling floods. I think most of you know we get real bad situations out there, and we get floods, we have poor return sockeye.

If you cut those flows through Seattle's operation or dam, it really makes a difference and has made a difference. And I think Seattle should be applauded for the improved performance we've had with the natural production because of the way they controlled the flows. And I served, as I said, on writing committees always looking see if we can improve that production, and do it in a way that's

17

1 constructive so we didn't harm the environment. We
2 knew we had a hatchery fish, we knew there's been a
3 lot of -- but we realized we could under the evolving
4 science be able to have hatchery production along with
5 wild production. And that these fish can be
6 interchangeable, and that's what we thought.
7 There is no other alternative that can be
8 cost effective or reliable as a hatchery. It's just
9 not out there. And if you don't build a hatchery,
10 you're just not going to fish. It's that simple. The
11 Washington Council of Trout Unlimited after careful
12 review of the draft supplemental environmental
13 statement and worst-case analysis it's going to allude
14 to reaffirms our strong support for the hatchery and
15 proposed operation including the adaptive management
16 plan.
17 As I said, I don't know of any other
18 hatchery that's ever received this kind of attention
19 with so many experts and scientists. And we always
20 liked the guys from the University of Washington
21 because many of us know them, undergraduate UW, and
22 we are pleased to know that some of the scientists
23 that have been involved in this project and they are
24 really first class.
25 Well, I'll be submitting some written

18

1 comments. My one criticism that I will offer up here
2 and it's regarding some of the assumptions that if you
3 look at it in that document. I think maybe it's
4 extreme, more extreme than I think is reasonable, and
5 therefore we would be significantly overstating the
6 possible adverse impacts, and one example is on
7 Page 1-14 where they assume that the number of
8 spawners reaching the Cedar River be about 20 percent
9 over the escapement goal, and the escapement goal is
10 about 300,000. That means you can have about 360,000
11 is what they use in their analysis, and that's not
12 quite reasonable.
13 Only once in 23 years of Department of Fish
14 and Wildlife data has that level been reached in Cedar
15 and that was in 1988. Over the last five years, the
16 average number of Cedar River spawners has been only
17 138,000, and even with expanded production of
18 Lake Washington Sockeye Harvest Management policy, we
19 have to wait to get 350,000 to get above that to get a
20 part and that's what we go for.
21 We've done a pretty good job of harvesting
22 all the fish to suppose he was available. So I just
23 don't see escapement more than 200,000, again, based
24 what we did in 2002.
25 Having said this, I still note that the

worst-case analysis concludes that the hatchery will not produce significant and adverse effects on the natural origin sockeye or other species of salmon, especially the ESA list, and it might be beneficial in some other respects if we calm down.

So we ask not only Seattle here, and they've been working well with us, but King County, because King County is another major player, that they cooperate with Seattle and expedite the completion for the Sockeye Hatchery. We have two King County Council members who co-chair Cedar River Council that provides
19 full oversight on the Cedar River and the fish populations.

The CRC is established by the Cedar River Basin Plan completed in 1994 has endorsed the hatchery, recognizes the hatchery -- those of you who have seen my articles, I've written fishing, hunting news and other places, and there was an article in the King County Journal this last Friday that realizes one person has caused us delay, and I'm not going to name that person.

But I think that we've got this extra work, fine piece of work, that we ought to move on and not one person should not be allowed to take away the heritage that a lot of us want to leave for our kids,

our grandkids. So as far as I see it, with the sockeye coming through the Ballard Locks and the lake fishery that's a special part of Seattle -- a lot of people see it just as important as Seafair, at least those of us who fish.

So let's make sure future generations have a chance to enjoy this resource, and as a grandfather, as I said, I care deeply about what I leave as a legacy for my five grandsons. I'm proud that my oldest grandson Andrew was able to be here tonight and spoke to you earlier.

19 So let's get on with it. And one last note, there was a city councilman, Dan Clawson, who was here earlier, and City of Renton is working closely with Seattle Public Utilities because the broodstock collection facility would be in Renton underneath the I-405 bridge. And he was going to comment, he will in written comments, say something to the effect that Renton and Seattle were coming together and looks very promising for that facility. So again, thank you for this opportunity.

MR. HABENICHT: Hi, my name is Gary Habenicht, H-A-B-E-N-I-C-H-T. First I would like to thank the staff of Seattle Public Utilities for your

tenacity, your forbearance, and your belief in the hatchery project, and please pass it on to other members of your staff because I mean that wholeheartedly.

I currently live in Landsburg at the headwaters, so to speak, of Cedar River, and I've lived there all my life as my father and grandfather before me. I've had the pleasure to fish with generation five and six at Lake Washington for sockeye. And as many of you in the audience who have spoken to the same things, the joy that comes with being able to fish with family members goes beyond just the fun of fishing, because it takes on a, so to speak, a spiritual sort of feeling to be able to do that, and those of you that have been able to do that you know what it feels like.

Jennifer James has spent quite a bit of time in Seattle as a psychologist said let's commit to the obvious. As I see it, based on what I've read tonight and what I've heard, there is no downside, just upside. So I see no particular reason why there should be much hesitation about going forward. But you always get curious as to what influences decisions, and you worry about that because you want right outcomes, correct outcomes, the outcomes that

seem to make the most sense.

And as the lady in the back said a little while ago, when she spoke she said, We need it now, and it made plenty of sense to me. My dad when he was 78 years old he worked at the temporary hatchery in 1979 and 1980, and this is the booklet that he kept. He took water temperatures. He provided drops of certain sorts of chemicals for the hatchery fish. The pictures inside this journal are black and white pictures of the original hatchery project on the Cedar River.

He believed in it, and he wanted us to believe in it and succeeding generations to believe in it, the value of the Cedar River Fishery. It's very, very important to us and the community that this project go through.

And finally, I was able to present it to the staff tonight, a letter from the Greater Maple Valley-Black Diamond Chamber of Commerce, and it's a short letter, so I'll read it very quickly.

This letter is in regard to the official comment to the Cedar River Sockeye Hatchery, SEIS. The Greater Maple Valley-Black Diamond Chamber of Commerce supports the proposed Cedar River Sockeye Hatchery project at Landsburg on the Cedar River in

King County. A permanent hatchery supports an economic development plan that embraces our rivers, trails, lakes, and recreational opportunities that our chamber believes will benefit the residents of South King County.

We know that the Cedar River Trail from Renton to Landsburg is a reasonable attraction and even greater attraction when the sockeye are running. The possibilities are endless for education, celebration and community partnerships that would ensure the future health and vitality of Cedar. We stand in strong support of the hatchery and ask that we be added to any mailing or notification lists so that we can continue to support the efforts to build this hatchery. Respectfully Debbie Malone, president of Chamber of Commerce. Business is behind this. Let's do it. Thank you.

MS. NOBLE: Rob Larsen followed by Corey Freeman and Mike Barnett. We have seven more speakers including those that have signed up to speak. We're moving along at a reasonable clip. If there are those of you who have not signed in that would like to speak, please let us know.

MR. LARSEN: I'm Rob Larsen, L-A-R-S-E-N. I guess I've heard all the things that everybody is saying and I echo what they said. I'm a scout master, and I always tell my scouts that anything worth having is worth working for, and this hatchery -- there's been a lot of people working for it for a long time. There's no reasonable reason why we shouldn't already have it.

I see some of the people -- I hope that that they live to see it, and if we continue to wait, they may not. I moved here 17 years ago, and I was hearing about a spawning channel, and I would just really like to see something happen now. We've got economic reasons to have it, science, Dr. Quinn at University of Washington, and all the other people that looked at this and have given no real reason why we shouldn't have it.

I have a great time every year when they have the sockeye season. My biggest complaint is that I can't really plan around it or do anything that allows me to take more people to enjoy it.

I went with some of the people in our club that I fish with one time I had four kids in my boat with me, and it's only 17 foot boat. We had three sockeye on and kids were smiling, and rods were going

21 every different direction. I don't know of another fishery that exists where I can take kids with a short attention span, I'm talking eight- and nine-year-old kids, put them on a fish that are big and have fun. Let's do it and let's do it now.

MR. FREEMAN: Good evening, my name is Corey Freeman, F-R-E-E-M-A-N. I'm here tonight representing the Recreational Fishing Alliance, Washington Chapter to be specific. You're in luck, you've got both the chair and vice chair and several board members in the audience as well. They just like to stay hidden.

22 A lot of excellent comments tonight. I'm not going to repeat the fact that this is the only hatchery that I know of that's had 14 years of practice and data and what's really going to happen. We already know what's going to happen. We've already been doing it. Now is our chance to make it permanent.

I'm not going to talk about the fact that we as Anglers, I'm assuming everybody here fishes or has fished at some point in their life. If you haven't, you don't know what you're missing.

We're on the forefront with a vanguard of

salmon restoration, salmon recovery. We're on numerous committees, numerous advisory boards. I know many people that spend more time at these committee hearings than they do on water. I'm not going to talk about the fact that it's a million dollars a day when we actually have a fishery.

What I'm going to talk about real quick is a bigger picture. State of Washington is the eighth in the nation for resident sport fishing expenditures, $854 million minimum a year to go chasing these slimy, little critters in the water, and if you guys are like me when you go fishing, you shouldn't be gambling

22 because you would never win. And yet I still spend the money, and I come home to hear my wife say, Yeah, that was worth it, wasn't it. And I told her that's why they call it fishing, not catching, at least in my respect.

That's the rosy picture. We're eighth in the nation. The downside we're seventeenth in the nation for nonresident expenditures. Oregon beats us. What do they have in the way of fishing? They have the Columbia River. What do we have? We have among other things Lake Washington. Lake Washington is the largest, single economic impact fishery in this state, from my understanding. The only one that comes close

22 is Columbia River Spring Chinook with one difference: They do it ever year. We get it about every three or four.

RFA supports this hatchery. It's a good idea. If the policymakers make the right decision, build this hatchery, they will build to live up to the promises of economic development, because as they said in Field of Dreams, if you build it, they will come, and we've already proven that. Thank you.

MS. NOBLE: Mike Barnett? Is he still here? Scott Cottell followed by Chuck Wischman, Dana Smith and Mark Gavin.

23 MR. COTTELL: My name is Scott Cottell, C-O-T-T-E-L-L. I represent the five member of the Cottell clan, unlike most of the other people here. Sockeye fishing my family looks forward to it. My sons asks me every year, Does it look like we're going to have it? And every year I say, well, I doubt it. A hatchery will change that.

Hatchery is well over do. We should have had a spawning channel 15 years ago. Every opportunity I get, I vote against Ron Simms. I blame him personally for us not having a sockeye fishing

23 season every year.

Hopefully, we're on the track to rectifying that problem. Economically it makes sense. Socially it makes sense. It's amazing how many people you see out there on the lake when there's a sockeye season. It is something that people look forward to. It's something that's well overdue. And hopefully we'll get the ball on track again. Thank you.

24 MR. WISCHMAN: I'm Chuck Wischman, W-I-S-C-H-M-A-N, and I represent the Lake Washington of Puget Sound Anglers on Mercer Island. I also represent a fellow by the name of Dave Payton who went probably close to 400 meetings trying to enhance Lake Washington. And before he died, he told me that. And when he died a couple of years ago, I sort of took up his position along with Bill here, and we've been going to those meetings and lots of them.

I want to thank the Seattle Public Utilities for all their work and fine expertise and how they collect people together. I want to go into a little bit of history. The Landsburg Dam has been in place a long time. Mitigation for the loss of fish through the years has been taken up by the Seattle Public Utility. The tribes and fishermen put a little

pressure on it, and so mitigation occurred.

Seattle Public Utility has wisely taken up the sockeye hatchery to try to make up for the loss of salmon opportunity for the tribes, sport fishermen and commercials because of the dam. They have now built a fish ladder around the dam for silvers, kings, rainbow and steelhead. This will not make up the loss through the years. It will make up for the year but not for the loss through the years. They have enhanced the Cedar River with wood debris and rocks and have done a fine job of it.

24 Now there are some people who want the mitigation to go all for habitat enhancement. Habitat enhancement alone can never replace the fish lost through the decades by the dam. We cannot completely rehabilitate the Cedar River due to the roads, a lot of homes.

The river used to meander through an area that's occupied by Renton, Boeing and PACCAR. We're not going to get rid of those. So we can't enhance it that well to bring back the fish that we've all lost. Sockeye are perfect as the redds are shallow, their bodies provide nutrients to the river and the lake, and when the sockeye hatch, they are in the lake within 24 hours.

While they are traveling down and to the lake they do provide a lot of food for all the other fish in the river, and once they get into the lake, they provide a lot of food for a lot of the fish that are in the lake, and they enhance then the kings and the silvers and the rainbow and the cutthroat.

They don't compete with other salmon or trout, but many become food for the river and the lake. Sockeye are a wise replacement for all the fishing opportunities lost through the years, and the only way to make them effective, is to have a hatchery. We know it works. It's been working for 14 years. We just need to double its output, and we can do that with a permanent hatchery. There's no other solution for the mitigation. So let's do something about it. Thank you.

MS. NOBLE: Dana Smith followed by Mark Gavin followed by Mike Gilchrist.

MR. SMITH: My name is Dana Smith, S-M-I-T-H. My comments are very short. You heard all the thoughts before by this group. Allow me to just read them to you. The scientific data speaks to moving forward on the permanent hatchery. The

25 economic impact speaks to moving forward with a permanent hatchery. The people are now speaking to move forward with permanent hatchery. So when are we going to build a permanent hatchery. Let's do it now. Thank you.

26 MR. GAVIN: Mark Gavin, G-A-V-I-N. I want to apologize in advance to you because I'm going through a thing with bifocals, and I can't look at you and read my paper at the same time. The other thing I want to apologize to you is this is an emotional issue to me, so bear with me through it.

I want to tell everybody because I'm really mad about the many years of delay that's been going on for not providing mitigation for the loss of fishing opportunities. The City of Seattle has an obligation to provide the mitigation for the loss of spawning habitat caused by the dam. To the city's credit, they are willing to provide the funding for that mitigation, "but, but, but" is what we keep hearing.

Over the years we continue to experience various delays that seem to kill the projects. More than a decade and a half ago, we were promised the Cedar River Sockeye spawning channel was approved, and then it died on the vine. We see the hatchery now

26 floundering because there are a couple of people with special interests that are manipulating the system.

My answer to that, and I think it should be everybody's answer, is if we can't get the hatchery built now, we need to challenge the city's permit for the dam. The technology that they use to determine the dam was years ago. It's nowhere like the DEIS statement that's been prepared here. It won't stand up if this won't stand up.

The reason I'm so adamant about it is we see politics behind the scenes. If the elected officials really wanted this, we would have had a spawning channel, we would have a hatchery already built. The reason time is important to me and we've lost years and years, much more than decade and a half, is that each of us only have a limited time on this earth. We only have so much time to raise our families, to enjoy life with them and then we pass on. And so much time has already been wasted.

In my specific case, my father died five years ago. My mother died last year. My father-in-law is currently gravely ill. My wife and I have two sons, 11 and 13. We would have liked to take our parents out with our children for experiencing family outings. We didn't have that opportunity

because of bureaucracy. And when I'm saying bureaucracy, it's not necessarily people that work in the different agencies. It's higher level people, and it's also special interest groups that are manipulating the system. That's why we're all here tonight, because of one or two people, and it's very frustrating to me, and it ought to be frustrating to you.

26 So I have my comments for the decision-maker in Seattle: It's either to approve the hatchery and build it now, or we're going to go after your permit, because even if you were to approve the hatchery right now, it would be still six years before the first fish comes back by the time you build the hatchery and the lag time for the fish to go to the ocean and return.

I'm not sure I'm going to be around here in six years. None of us can guarantee our life expectancy, and I'm tired of waiting. Thank you.

MS. NOBLE: The last speaker has signed up is Mike Gilchrist. If there are others of you who would either like to add to previous comments or make comments anew, if you would come on the line on that side, I would be happy to just have you come right up.

27 MR. GILCHRIST: My name is Mike Gilchrist G-I-L-C-H-R-I-S-T. I am a chairman of the board for the Washington State Chapter of Recreational Fishing Alliance. I will be brief.

Our organization has confidence in the science. In fact, we have confidence in all aspects of this project. We are committed to support this fishery, and we're absolute firm support of this hatchery going forward. An observation: Of those of you who are taking an evening to come out to attend this meeting, I have yet to hear of anyone in an opposition of this hatchery. Thank you.

28 MR. KASISCHKE: Hi, I'm Martin Kasischke. K-A-S-I-S-C-H-K-E. I'll be brief. You heard recently, earlier, a comment about the impediment brought by our local politicians, and specifically the King County executive. It was in the paper today that David Irons, who is a current King County Council member and a supporter, who has publicly endorsed this project, will announce I believe tomorrow or Saturday his candidacy for King County executive. I hope you will support him, and he will support the project. Thank you.

MR. FINNEY: All right. My name is Sean Finney, F-I-N-N-E-Y. I'm 35 years old. I grew up here in the local area, and I remember fishing in Cedar River for steelhead, and I've watched that fishery go basically downhill. And I remember in the '80s going out on Lake Washington fishing for sockeye, dragging around a big, orange boat, not knowing that down the road we -- but it was for some of the days when I learned how to run a boat, learned how to run it down river, we would fish raft while they weren't any even fish rafts.

29 It will be very nice to be able to do that fishing with my son who is now five, and I think that's one of the things -- we haven't really heard much about the educational purposes, and in the last couple of years, my son's preschool class they've gone on a couple of expeditions to some trout farms and also some hatcheries. And I remember when we went to the Issaquah Salmon Days that's when the kids together went down there, and I saw Dave Buener and his kids there. They were talking about the fish. And there was people talking about the different types of fish, the sockeye fishery, and maybe one day being able to educate the kids.

I work with a lot of kids on a daily basis, and spawning some nights when I'm at my business. I'm tying up salmon leaders. I'm organizing stuff. And some of these kids actually already know what's going on. They are like, Hey, are you getting ready for sockeye fishing. Well, you can never pinpoint. You don't know if there's going to be a season. Last time I checked when I bought my fishing license, it was an annual license, and it would be nice to say that we can fish annually.

I've got one of my neighbors here and we

29 were out in Elliott Bay fishing for kings, and we talked about the fishery, and we didn't even know what was going to happen with that. But I think educationally it would be good for the younger kids. A lot of things pulling on the kids today between getting them to do right and wrong, and I think it would be a good thing to have to help educate the kids as well and talk about how the fish come about, what happens to the travels, and how they come back and whatnot.

I also want to thank everybody here that's done a lot of work on this project. I'm glad you guys are able to do it because I wouldn't know where to start. But my hat is off for whoever has worked hard

29 for the project. I hope the time has come, we've jumped through enough hoops, its time to build a hatchery. I'm 35. And like Mark said, it's going to be a couple of years at least if we start tomorrow this hatchery before fish would come back. So let's get her done.

MR. WALKER: My name is Don Walker, W-A-L-K-E-R. I live in Sequim. There's a lot of smarter people here that said a lot of things that I don't want to add to or I can't, but what I would like to do is talk about some real faces. Some real money. I've been fishing this fishery ever since I came to this country in '63. What I would like to talk to you is about the people that I've seen fishing
30 this over the years.

Used to be a couple that would come in Renton, a little old lady, tiny, they had a boat in the back end of their pickup. I wouldn't let my mother ride around in. She had a pair of long gloves with the fingers cut out, never saw those before, except for in the movies, and they would be out there fishing, and, you know, by nine o'clock they had their limit and go on home.

I don't know how many of you people know

the man with the duck. I fished around him for a long time because I found out when you're close to a lot of outfits in the water, that helps your fishing.

The scout leader left. The other one is still here. I want to talk to you about your scouts. I fished with a young man who had a ski boat, of all things, and he would come down fishing with that contraption, and it would be -- it looked like -- there was people and kids and fishing poles sticking out all over the Sound. When it got a little slow in the afternoon, those kids get a little bored and they would start going swimming.

30 Now, if you're taking your scouts, please take swimming suits for them, or I don't care if they go skinny-dipping. But I can tell you -- give you a hot tip, when things get slow in the afternoon, slide up next to one of those kids that are jumping in the water, shakes the fish up. Fishing improves. There's my hot tip of the day.

One year we were fishing along the west side of Mercer Island, and it was the race day. I don't know if you've ever been here, but I can tell you it's the damndest crazed you've ever seen. There's boats that come out of that Coulon ramp full kids with inner tubes and everything else. If the

patrol was there catching people, I know they couldn't put that many life jackets in the boats that they are supposed to have, they could have made a pile a money giving away tickets for no life jackets. But we found out if you fish right on the track where those people are, again the fishing improves.

There was this duck that used to fish out there. I met the man eventually. He was quite a guy. He had took -- that duck would be full of people all handicapped. He couldn't find a way to get wheelchairs into his duck, so they went and somehow put up a forklift so he could do that. I always wanted to ride with him. He wouldn't take me. He said I was too big and bothered. But that's the kind of people that fish there.

There is the other people, other people you never see that don't get a chance to fish, and that's what I would like to speak to. I can remember I think it was '84 or something when we had the season that didn't end, just cut off at the end of the year. Most of you diehard fishermen left the lake. I placed myself in December.

Now, I'm catching fish as dark as that man's hat, and I ain't telling you, but I could tell you, I couldn't tell the difference. I was

from Montana. I wouldn't know a good fish from a bad one. They all eat good. We used to take -- the limit was six. I would go and catch my -- you can't find a fishing partner in December. You cannot find a fishing partner.

I used to come home with my six, and I told my wife, I'm going to fillet the worst looking one of the bunch, and when it ain't good, I'm going to quit fishing. And I never did quit right up until -- I think was out right around mid-December. So think about that.

I would like to talk about money. Coming down from Sequim cost me $200 to get here and get home. That's the ferry -- if you take the ferry it was 60-some dollars last time I did it. I tried to come down with my boat. Pretty empty. I don't like to haul that gas around even it is more expensive here in Seattle. I've got a hundred gallon tank. I try to come in with as little gas as I can. I'm going to fill it up, and I'll probably -- the season don't last too long, I'll go home with it whatever is left.

So there's money I spent. Fortunately, my daughter lives in Renton, so I don't have to spend money for motel and stuff, but I would. I do not have a reservation in Neah Bay in July this year because

30

I'm waiting for the science. That's my first priority.

I was lucky many years ago, next door to where we lived was a young man, and he could suck up a lot of deer tuck. He's a big shot lawyer here in town. And he's got a nice home on the lake, and he's got a wife who loves to fish. So I've got a place to moor my boat now. I can tell you was it fun to drive by the lines at the launch ramp. That's another reason I wouldn't give up. I would rather come up here than go to Neah Bay for that.

That's the thing I would like you people to think about here in this thing. Again, I thank you all. Don't too many of you come fishing in December so I can have the place to myself. Thank you.

MS. NOBLE: Are there any others who would like to add to your previous comments or make any new comments? Just over 75 people come out tonight. I appreciate very much your time and effort in coming out. I appreciate the good humor of your comments. And there was some very important comments that we will definitely be taking into consideration as we finalize this draft.

I suspect that there will be some of you who have other comments that you'll think of or

are thinking of and would prefer not to stand up for, we do have comment sheets out in the lobby, and we will be accepting comments through March 21st, which is a Monday, and it is a business day on Monday, and I would be very delighted to receive any further comments that you have. Again, thank you very much for taking your time to help us with this.

(Hearing concluded at 8:45 p.m.)

1 REPORTER'S CERTIFICATE

2 I, KAREN ALIGO, the undersigned Certified Court
3 Reporter and Notary Public, do hereby certify:
4 That the sworn testimony and/or proceedings, a
5 transcript of which is attached, was given before me at
6 the time and place stated therein; that any and/or all
7 witness(es) were by me duly sworn to testify to the truth;
8 that the sworn testimony and/or proceedings were by me
9 stenographically recorded and transcribed under my
10 supervision, to the best of my ability; that the foregoing
11 transcript contains a full, true, and accurate record of
12 all the sworn testimony and/or proceedings given and
13 occurring at the time and place stated in the transcript;
14 that I am in no way related to any party to the matter, nor
15 to any counsel, nor do I have any financial interest in the
16 event of the cause.
17 WITNESS MY HAND AND SEAL this 18th day of
18 April 2005.
19
20
21 KAREN ALIGO
Certified Court Reporter
22 CCR #2507
Notary Public in and for the State
23 of Washington, residing in King
County. Commission expires October 27, 2008.
24
25

Responses to Comment Letter TR (Public Hearing Transcript)

TR-1. Comment noted.

TR-2. Comment noted.

TR-3. Comment noted.

TR-4. Comment noted.

TR-5. Comment noted.

TR-6. Comment noted.

TR-7. Comment noted.

TR-8. Comment noted.

TR-9. Comment noted.

TR-10. Comment noted.

TR-11. Comment noted.

TR-12. Comment noted.

TR-13. Comment noted.

TR-14. Comment noted.

TR-15. Comment noted.

TR-16. Comment noted.

TR-17. Comment noted.

TR-18. Comment noted. The assumption that the escapement goal would be exceeded by 20 percent was a recommended assumption that the worst case analysis workshop participants received to provide a worst case situation. This reflects the possibility of exceeding the current escapement goal of 300,000 in the Cedar River by underharvesting the return. The superimposition group in the workshop chose to use the current escapement goal of 300,000. While it is acknowledged that such a scenario may overstate likely adverse impacts, such an approach was used to provide decision-makers with a conservative worst case scenario on which to base their decisions. This approach is consistent with SEPA rules for developing worst case evaluations, and it effectively responds to the Hearing Examiner's decision.

TR-19. Comment noted.

TR-20. Comment noted.

TR-21. Comment noted.

TR-22. Comment noted.

TR-23. Comment noted.

TR-24. Comment noted.

TR-25. Comment noted.

TR-26. Comment noted.

TR-27. Comment noted.

TR-28. Comment noted.

TR-29. Comment noted.

TR-30. Comment noted.