Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

ENVIRONMENT, FISH AND WILDLIFE

March 11, 2009

In reply refer to: KEWR-4

Mr. Tony Grover, Fish and Wildlife Division Director
Northwest Power & Conservation Council
851 S.W. Sixth Avenue, Suite 1100
Portland, OR 97204-1348

Dear Mr. Grover:

With this letter, Bonneville Power Administration (BPA) is submitting a 2008 Federal Columbia River Power System (FCRPS) Biological Opinion (BiOp) project narrative for Independent Scientific Review Panel (ISRP) review. As you know, the 2008 FCRPS BiOp is a 10 year operations and configuration plan to mitigation for the adverse effects of the hydro-system on the 13 listed fish under the Endangered Species Act (ESA). The Reasonable and Prudent Alternative (RPA) of the FCRPS BiOp calls for BPA and the other federal Action Agencies to implement specific mitigation actions to avoid jeopardy and adverse modification of the critical habitat of ESA listed Columbia River fish.

To this end, BPA will continue to fund ongoing Fish and Wildlife Program projects that support the RPA, and develop new projects designed to contribute to hydro, habitat, hatchery and predation management activities required under the 2008 FCRPS Biological Opinion. Additionally, many of the new FCRPS BiOp RPA projects will also assist BPA in meeting its mitigation obligations under the NW Power Act, and supplement the Northwest Power and Conservation Council's Fish and Wildlife Program. As sponsors develop narratives for these projects, we will submit them for ISRP review.

We are enclosing the detailed narrative for Chum Salmon Enhancement in the Lower Columbia River, Project #2008-710-00 for immediate ISRP review. The purpose of the project is to develop an Integrated Strategy to Implement Habitat Restoration, Reintroduction and Hatchery Supplementation in the Tributaries below Bonneville Dam. The project is intended to implement several actions required by the FCRPS BiOp RPA:

a) RPA action 42: "Fund a hatchery program to re-introduce chum salmon in Duncan Creek including capital construction, implementation and monitoring and evaluation as long as NOAA Fisheries considers it beneficial to recovery and necessary to reduce risk of the target population." This is essentially the ongoing work previously funded under Project 2001-053-00, Reintroduction of Lower Columbia Chum Salmon into Duncan Creek, and now included in Project 2008-710-00.

b) RPA action 42: "Fund the assessment of habitat potential, development of reintroduction strategies, and implementation of pilot supplementation projects in selected Lower Columbia River tributaries below Bonneville Dam." This is new work.

c) RPA action 17: The project will contribute to monitoring of chum salmon spawning in the mainstem Columbia River in the area of the Ives Island Complex and/or access to the Hamilton and Hardy Creeks for this spawning population.

The initial contract is slated to start May 1, 2009 with a BPA FY09 funding commitment of $265,082. This will provide for planning stages of the project and initiation of the 3-Step Council process for the Grays River chum salmon supplementation program. It will also provide habitat work to remove the canary reed grass from the spawning channel graveled/watered areas before the 2009 chum salmon spawning season.

If you have questions about the project narrative, please contact the project sponsors, Bryce Glaser at *glasebgg@dfw.wa.gov* or Todd Hillson at *hillsth@dfw.wa.gov*. If you need any additional information from the BPA project manager, please contact Tracy Hauser at *tlhauser@bpa.gov* or Marchelle Foster at *mmfoster@bpa.gov*, who is helping to coordinate the ISRP.

Thank you for your assistance, we look forward to working closely with you and your staff as we implement BiOp projects.

Sincerely,

Bill Maslen
Director, Fish and Wildlife

Enclosure: Chum Salmon Enhancement in the Lower Columbia River Project Narrative

Narrative

The 2008 Federal Columbia River Power System (FCRPS) Biological Opinion (BiOp) is a 10 year operations and configuration plan to mitigation for the adverse effects of the hydro-system on the 13 listed fish under the Endangered Species Act (ESA). The BiOp provides mitigation actions that are required of the FCRPS action agencies to avoid jeopardy and adverse modification of the critical habitat of ESA listed Columbia River fish. Ongoing projects supported and new projects developed are designed to contribute to hydro, habitat, hatchery and predation management activities required under the 2008 FCRPS Biological Opinion. Additionally, projects assist Bonneville Power Administration (BPA) in meeting its mitigation obligations under the NW Power Act, and supplement the Northwest Power and Conservation Council's Fish and Wildlife Program.

Introductory Statement: A detailed proposal describing the full scope of this project has been submitted to BPA and can be found attached in PISCES. The work outlined for FFY 2009 focuses on development of an integrated program for strategic implementation of habitat restoration and supplementation/reintroduction. This project includes habitat, RM&E, and hatchery components, which we have attempted to summarize in the format below. We realize additional questions may arise during review and suggest a face to face presentation of the project may be useful. If such a presentation is deemed beneficial, please contact us to coordinate a convenient time.

Table 1. Proposal Metadata
Complete information can be found under contract # CR-113766 of Project #2008-710-00 in PISCES

Project Number	2008-710-00
Proposer	Washington Department of Fish and Wildlife
Project Title	Chum Salmon Enhancement in the Lower Columbia River – Development of an Integrated Strategy to Implement Habitat Restoration, Reintroduction and Hatchery Supplementation in the Tributaries below Bonneville Dam.
Short Description	Promote recovery of lower Columbia River (LCR) chum salmon populations through development of an integrated program for chum salmon habitat restoration and supplementation/reintroduction.
Province(s)	Basinwide
Subbasin(s)	Basinwide
Contact Name	Bryce Glaser, Todd Hillson
Contact email	glasebgg@dfw.wa.gov; hillsth@dfw.wa.gov

Information transfer:

A. Abstract

Purpose: Promote recovery of lower Columbia River (LCR) chum salmon populations through development of an integrated program for chum salmon habitat restoration and supplementation/reintroduction in FFY 2009, followed by a strategic implementation of the program in FFY 2010.

BPA identified two new projects for Columbia River basin chum salmon in its Start of Year (SOY) budget for FY 2009 - #2008-710-00 Assess habitat potential for reintroduction of lower Columbia River chum and #2008-711-00 Implement chum reintroduction below Bonneville Dam. This proposal represents the Washington Department of Fish and Wildlife's (WDFW) comprehensive strategy for implementing these projects.

In this first year we will complete the groundwork that WDFW believes must be done prior to full initiation of these two projects including:

1) An assessment of priority habitat restoration and/or chum channel sites identifying benefits to chum.
2) An updated stock status review of LCR chum salmon population structure and abundance necessary to prioritize restoration and guide future implementation of supplementation/reintroduction.
3) Adaptive management of existing supplementation programs, including continuation of the Grays River program.
4) Development of a stepwise enhancement program that utilizes supplementation/reintroduction to rebuild LCR chum populations.
5) Development of a comprehensive program to monitor LCR chum salmon populations and evaluate the effectiveness of habitat restoration and supplementation/reintroduction actions.

B. Problem statement: technical and/or scientific background

Chum salmon abundance in the LCR has declined to critically low levels, and is currently supported by three main populations – those spawning in the Grays River, WA, another spawning in the mainstem Columbia River and tributaries just below Bonneville Dam and a third that utilizes two small spawning areas in the mainstem Columbia River near the I-205 Bridge. The proposed project is intended to develop an integrated program of habitat restoration, supplementation/reintroduction, and monitoring & evaluation that can be implemented strategically beginning in federal fiscal year FFY 2010 to promote significant recovery of chum salmon throughout the LCR.

Problem Statement - Background

The National Marine Fisheries Service (NMFS) listed LCR chum salmon as threatened under the Endangered Species Act (ESA) in March 1999 (64 FR 14508, March 25, 1999). The listing was in response to the reduction in abundance from historical levels of more than one-half million returning adults to fewer than 10,000 present-day spawners (Johnson et al. 1997). Harvest, habitat degradation, changes in flow regimes, riverbed movement and heavy siltation has been largely responsible for this decline (Johnson et al. 1997).

Prior to 1997, only two chum salmon populations were recognized as genetically distinct in the Columbia River, although spawning had been documented in many lower Columbia River tributaries. The first population was in the Grays River (RKm 34), a tributary of the Columbia River, and the second was a group of spawners utilizing the mainstem Columbia River just below Bonneville Dam (RKm 235) adjacent to Ives Island and in Hardy and Hamilton creeks (Johnson *et al.* 1997). Using additional DNA samples, Small *et al.* (2006) grouped chum salmon spawning in the mainstem Columbia River and the Washington State tributaries into three groups: the Coastal, the Cascade and the Gorge - the Coastal group comprised those spawning in the Grays River, Skamokawa Creek and the Chinook River, the Cascade group comprised those spawning in the Cowlitz (both summer and fall stocks), Kalama, Lewis, and East Fork Lewis rivers, with most supporting unique populations and the Gorge group comprising those spawning in the mainstem Columbia River from the I-205 Bridge up to Bonneville Dam and those spawning in Hamilton and Hardy creeks.

The Lower Columbia/Willamette Technical Recovery Team (TRT) developed three geographic strata within the Columbia River chum salmon Evolutionarily Significant Unit (ESU) that reflects this structure and incorporates Oregon chum salmon populations (Table 2). All populations within the ESU are considered either at high or very high risk of extinction; many are severely depressed and the status of many other populations is unknown (HSRG 2008).

Table 2. Extinction Risk of Columbia River Chum Salmon Populations[1] as Identified by the Lower Columbia/Willamette TRT (HSRG 2008).

Populations	Extinction Risk
Coast Stratum	
Grays/Chinook (WA)	High
Elochoman (WA)	High
Mill/Abernathy/Germany (WA)	Very High
Youngs Bay Tribs. (OR)	Very High
Big Creek (OR)	Very High
Clatskanie (OR)	Very High
Scappoose (OR)	Very High
Cascade Stratum	
Cowlitz (WA)	Very High
Kalama (WA)	Very High
Lewis (WA)	Very High
Salmon (WA)	Very High
Washougal (WA)	High
Clackamas (OR)	Very High
Sandy (OR)	Very High
Gorge Stratum	
Lower Gorge Tribs.	Very High/Medium
Upper Gorge Tribs.	Very High/ Very High

[1] From Washington's Lower Columbia River Recovery Plan and McElhany et al. 2007 for Oregon populations

HABITAT

FFY 2009 – Habitat Restoration and Chum Channel Site Assessment

The LCFRB Salmon Recovery Plan (2004) is a comprehensive document that outlines an integrated approach for recovery of LCR salmonid populations. For LCR tributaries in Washington State, limiting factors affecting salmonid populations are identified, habitat quantity and quality is assessed at the stream-reach level, and stream reaches are prioritized for preservation and restoration. The LCFRB has identified a 6-year habitat work schedule (http://www.lcfrb.gen.wa.us/2008%20HWS.htm) for implementation of it's habitat restoration strategy and sponsors community-based work groups to develop and implement watershed specific habitat restoration plans. For Oregon LCR salmonid populations, a similar recovery planning process is underway.

The intent of this proposal is not to conduct or re-evaluate habitat assessments already completed or compiled through the LCFRB or other processes, but instead to utilize the LCFRB Recovery Plan, existing stream habitat assessments and restoration project lists to develop a prioritized list of habitat restoration projects and/or locations within the LCR that would be the most beneficial to chum salmon.

The construction of artificial, or restoration of historic chum spawning channels has been used as tool in supplementing natural spawning chum salmon populations, by mitigating for lost habitat. In British Columbia, Canada, large-scale artificial chum channels are utilized to support production level chum salmon programs. Some channels are associated with a hatchery, others are independent, for example:

- Big Qualicum Hatchery – contributes 300,000 adult chum to fisheries
- Big Qualicum – spawning channel – capacity for 20,000 chum spawners – 20 million fry
- Little Qualicum – artificial channel - capacity for 50,000 chum spawners – 59 million fry
- Stave River – off-channel enhanced spawning area

In the LCR examples of constructed/restored chum spawning channel locations include:

1) Gorley Springs channel, which operated on the Grays River from mid 1980s until a major river avulsion overtook the area in 1998,
2) Hamilton Creek Spring Channel restored in the mid-1990s, and
3) Duncan Creek spawning channels restored in 2001.

Stream surveys conducted on WA state tributaries of the lower Columbia River from 1998-2000 identified spring-fed sites where chum salmon were observed spawning. A review of these locations for potential habitat improvements and/or a chum salmon spawning channel will be included in this assessment.

FFY 09 Habitat work

Hamilton Spring channel is one of only two (Duncan Creek spawning channels being the other) protected off-channel chum salmon spawning areas in the Bonneville area. Non-native vegetation (reed canary grass and Himalayan blackberry) has encroached into the spawning channel to the extent that it is reducing the amount of available spawning area. In addition, the canary reed grass captures fine sediments instead of letting them flush from the area, reducing the quality of the spawning gravel.

To remedy this, we propose to remove the canary reed grass from the spawning channel graveled/watered areas. Removal will be done using hand tools only.

FFY 2010 - Habitat Restoration, Chum Channel Design and Implementation

Based on the FFY 2009 assessment, high priority habitat restoration and chum spawning channel projects will be submitted for design and implementation in FFY 2010. The number of projects moved forward in a single year will be dependent upon project scope, complexity, and ultimately project cost. The timeline for project completion is also driven by these factors; smaller scale, less complex projects are more easily designed, permitted and constructed than large, complex projects. We expect that between 1 and 3 projects would be initiated in FY 2010.

RESEARCH/MONITORING/EVALUATION

FFY 2009 – Sample Analysis and Stock Status Review

The genetic analysis completed by Small et al. (2006) utilized samples collected through 2002. Since then, additional monitoring and sample collection (genetic tissue samples and otoliths) has been completed. An updated stock status review of LCR chum salmon, population (genetic) structure, relationships and abundance is critical to identifying and prioritizing where restoration actions will be most beneficial, what type of supplementation or reintroduction strategy is appropriate, and identifying potential donor stocks for these programs. This update/review will include:

- Analysis of genetic tissue and otolith samples collected in 2003-08 (Table 3).
- An updated analysis of LCR chum salmon population (genetic) structure.
- Review and update of historic and recent chum salmon abundance data.
- Review of existing supplementation programs (i.e. Grays River and Duncan Creek) – determine the contribution of supplementation programs to the natural spawning population.
- Review of recovery strategies outlined in the LCFRB's Recovery Plan (2004), the FCRPS Biological Opinion and coordination with other relevant management entities.

Table 3. Number of LCR chum salmon otolith and DNA samples proposed to be analyzed for stock status review.

Location/Area	Otolith Samples	DNA samples
Coast Stratum		
Grays and Chinook Rivers	200	150
Elochoman River and Skamokawa Creek	271	231
Big Creek Hatchery (OR)	0	50
Germany, Abernathy and Mill Creeks	15	11
Cascade Stratum		
Cowlitz and Coweemen Rivers	0	49
Lewis and NF Lewis Rivers	96	37
Kalama River	1	0
Gorge Stratum		
Mainstem spawners		
I-205 (Washougal Population)	0	150
St Cloud/Multnomah line to Bonneville	0	150
Tributary spawners		
Misc. Tributaries	46	43
Hamilton and Hardy Creeks	0	100
Above Bonneville Dam		
All populations	5	27
All locations in 2008 (estimated)		
	100	100
TOTAL	734	1,098

Population Monitoring and Evaluation

FFY 2009 Population Monitoring and Evaluation Program Development

A well-developed population monitoring and evaluation (M&E) program for LCR chum salmon should address three needs associated with recovery actions:

1) Biological monitoring necessary to assess stock status via Viable Salmonid Population (VSP) parameters associated with ESA listing and potential de-listing criteria.
2) Biological monitoring to provide an adaptive management feedback loop to improve ongoing and future supplementation/reintroduction programs.
3) Effectiveness monitoring to provide an adaptive management feedback loop to improve ongoing and future habitat restoration actions.

Currently, for most LCR salmon and steelhead populations, monitoring is directed at addressing stock status. For LCR chum salmon, the supplementation programs on the Grays River and reintroduction at Duncan Creek have prompted increased monitoring for these populations. As future habitat restoration projects and supplementation programs are implemented, the need for a coordinated M&E program will increase.

Since ESU status is a role up of individual population status, all adult chum salmon populations within the ESU must be monitored; however, the level of monitoring for each population is not likely to be equal. Populations designated as primary by the LCFRB or core by the Lower Columbia/Willamette TRT (Table 4) are likely to be monitored more intensively than contributing or stabilizing populations. As supplementation/reintroduction programs are implemented monitoring needs may change and adaptive management will be required.

In FFY09, we propose to begin development of a comprehensive M&E framework for LCR chum populations that incorporates biological monitoring (for adult spawners and juvenile outmigrants) commensurate with their recovery designation, while addressing monitoring needs associated with implementation of supplementation/reintroduction programs and habitat restoration actions.

Table 4. Recovery designations of Lower Columbia River and Gorge chum populations (HSRG 2008).

Populations	Recovery Designations		
	LCR Salmon Recovery Plan (WA)	LCR Salmon Recovery Plan (OR)	TRT
Coast Stratum			
Grays/Chinook (WA)	Primary	Core	Core
Elochoman (WA)	Primary	Core	Core
Mill/Abernathy/Germany (WA)	Primary		
Youngs Bay Tribs. (OR)	Primary	Core	
Big Creek (OR)	Contributing	Core	
Clatskanie (OR)	Contributing		
Scappoose (OR)	Contributing		
Cascade Stratum			
Cowlitz (WA)	Contributing	Core	Core
Kalama (WA)	Contributing		
Lewis (WA)	Primary	Core	Core
Salmon (WA)	Stabilizing		
Washougal (WA)	Primary		
Clackamas (OR)	Contributing	Core	Core
Sandy (OR)	Primary		
Gorge Stratum			
Lower Gorge Tribs.	Primary	Core	Core
Upper Gorge Tribs.	Contributing		

FFY 2010 - Implementation of Population Monitoring and Evaluation Plan

In FFY 2010, we propose to implement a biological monitoring framework for LCR chum salmon in accordance with the plan developed

HATCHERY

FFY 2009 - Maintain Grays River Supplementation Program / Develop Strategy for Future Supplementation/Reintroduction Programs.

Grays River Supplementation

Chum salmon in the Grays River have been identified as a primary population targeted to improve to a level that contributes to recovery of the species (LCFRB 2004). The Grays River population is the only remaining substantial population of LCR chum salmon (recent natural origin returns consistently greater than 1,000 adults). An artificial, spring-fed spawning channel was constructed in 1985 off of Gorley Creek to provide protected off-main-channel spawning habitat. In 1998, WDFW initiated a chum salmon supplementation program using native stock at the Grays River hatchery. This program has continued through 2007, but is currently unfunded. This supplementation effort was initiated because it was believed that most successful natural spawning was limited to the protected spring-fed areas in Gorley and Crazy Johnson creeks. Successful spawning in these creeks was believed to have a high risk of failure due to flooding and potential re-alignment of the mainstem Grays River. In December of 1998, a freshet caused

a major avulsion through a man-made dike that had protected Gorley Creek and the artificial spawning channel; the mainstem Grays River now runs through the Gorley Creek streambed. The loss of the Gorley Creek off-channel spawning area increased extinction risk by limiting the most successful spawning to approximately half of Crazy Johnson Creek. The WDFW believes that supplementation should continue until other spawning sites outside Crazy Johnson Creek are restored and proven to be successful.

A geomorphological and hydrological assessment of the Grays River and its tributaries from RM 11 to the headwaters was implemented in 2003 (BPA Project # 200301300), in order to gain a better understanding of the location, distribution, characteristics and stability of salmonid spawning habitat within the basin, with emphasis on chum salmon. The focus of this project has switched to implementation of habitat restoration projects identified through the assessment and BPA is currently funding a large-scale habitat restoration project in the Gorley Reach to be completed in summer 2009. A goal of this project is to stabilize and reconnect Gorley Springs to the mainstem Grays River.

Infrastructure, staffing, and permitting are in place to continue this supplementation project without interruption. This program buffers catastrophic risk to the Grays River chum population and will become more important if Grays River chum are used as the donor stock for other LCR supplementation/reintroduction programs in the future.

The Grays River program was modeled on, and developed under, the guiding standards of successful chum salmon supplementation programs implemented in the Puget Sound and Hood Cannel (WDFW and PNPTT 2000, Ames and Adicks 2003, Johnson et al. 2003). Broodstock from returning chum salmon are collected in the fall from the mainstem and West Fork Grays River and Crazy Johnson Creek. Spawning is conducted at WDFW's Grays River Hatchery (located on the WF Grays River) where eggs are incubated and hatched. Fry are thermally marked (detectable on the otolith) and are released in the spring of the following year. Specific details of the program are described in the Draft Grays River Chum Salmon Hatchery & Genetic Management Plan (HGMP) submitted to NMFS (WDFW 2004a). This supplementation program is very similar to the program implemented under BPA project # 200105300 Reintroduction of Chum salmon into Duncan Creek, which has been approved through the Northwest Power and Conservation Council's (NPCC) 3-Step Review process.

In FFY 2009, we propose to avoid interruption of the Grays River chum salmon supplementation program by capturing broodstock with the goal of collecting 100,000 to 200,000 viable eggs. As part of the aforementioned stock status review, contribution of supplementation program releases to the natural spawning population will be assessed through analysis of otolith and DNA samples. In addition, a 3-Step Review for the program will be initiated through the NPCC process for completion by the beginning of FFY 2010.

Future Supplementation/Reintroduction Strategy Development

To date, WDFW's restoration approach for chum salmon has been as follows:

Step 1. Determine if remnant populations of chum salmon exist in the system.

Step 2. If such populations exist, develop stock-specific recovery plans involving habitat restoration that include the creation of spawning refugias, supplementation where necessary, and a habitat and fish monitoring and evaluation plan.

Step 3. If chum salmon have been extirpated from previously utilized streams, develop reintroduction plans that utilize appropriate genetic donor stock(s), and integrate habitat improvement and fry-to-adult survival evaluations.

As exemplified by the Grays River hatchery program described above, conservation level hatchery supplementation programs can be utilized to buffer populations against catastrophic risk. As habitat restoration and other recovery efforts for depressed LCR chum populations move forward, supplementation of remnant populations or reintroduction of extant populations can also be an effective tool in jump-starting recovery and utilization of newly restored/created habitat. The BPA funded Duncan Creek reintroduction project (BPA project #2001-053-00) is an example of the latter. Results from this on-going project will help to direct future supplementation strategy development. A detailed M&E plan for Duncan Creek reintroduction strategies has been developed (Schroeder 2000) and will provide a useful template for future programs.

Stream surveys conducted by WDFW and PSMFC staff in recent years have documented low-level chum spawning activity in many of Washington States' LCR tributaries. Spring-fed seeps and upwelling areas were identified during these surveys; genetic tissue and otolith samples were collected from chum salmon carcasses in these locations (Table 3). The proposed stock status review, to be completed as part of this project, is intended to provide updated information on genetic structure useful in further determining if chum spawning in these areas are genetically distinct remnant populations or extensions of larger neighboring populations. Otolith analysis will be used to detect straying from the Grays River or Duncan Creek supplementation programs.

In FFY 2009, we propose to develop a strategy that incorporates population recovery designations (Table 4), updated genetic and abundance information and potential habitat restoration/chum channel projects in identifying 1) priority populations for supplementation/reintroduction, 2) preferred methods of supplementation/reintroduction for these populations, and 3) the genetic stock source (donor stock) for each.

FFY 2010 – Supplementation Program Development and Implementation

Grays River

Continue the Grays River chum salmon hatchery supplementation program. Collect sufficient adults to produce approximately 200,000 otolith marked fed-fry for release into the Grays River system.

Duncan Creek

Reinitiate the Duncan Creek hatchery supplementation program (funding reductions in FFY08 eliminated this program). Hatchery infrastructure (Washougal), an HGMP, and an approved 3-

step review are currently in place. The program will produce otolith marked fed-fry for direct release at Duncan Creek.

New Programs

As other priority habitat restoration and chum channel projects are designed and implemented, corresponding supplementation/reintroduction programs will be developed. New programs will need to be approved through NPCC 3-step review process, which includes development of an HGMP incorporating an analysis of risks (partial/total hatchery loss, predation, competition, disease, loss of genetic variability between or within populations) resulting from a hatchery supplementation program, determining allowable fish release levels, disposition of excess individuals, and maintenance of ecological and genetic characteristics of the natural population (brood stock collection, spawning, incubation, juvenile rearing and smolt release procedures).

Monitoring and evaluation standards will be developed to collect data needed to evaluate performance measures, identify adaptive management actions that can be taken if the program is not meeting goals, and to determine when to stop the program. Monitoring and evaluation plans will be modeled on the existing M&E plan for Duncan Creek (Schroder 2000) and existing Grays River chum and Washougal Hatchery HGMPs (WDFW 2004a, 2004b).

C. Rationale and significance to regional programs

BPA Projects
BPA identified two new projects relating to lower Columbia River basin chum salmon in its Start of Year (SOY) budget spreadsheet for FY 2009 - #2008-710-00 Assess habitat potential for reintroduction of LCR chum and #2008-711-00 Implement chum reintroduction below Bonneville Dam. This proposal represents the Washington Department of Fish and Wildlife's (WDFW) comprehensive strategy for implementing these projects.

FCRPS Biological Opinion
The Federal Action Agencies have developed both habitat and hatchery-related proposed actions for LCR chum salmon -- in support of the Biological Opinion for the Federal Columbia River Power System (FCRPS) (Federal Agencies May 21, 2007; Source: www.salmonrecovery.gov). The enhancement approach that we propose for chum salmon in this proposal incorporates both habitat improvement, reintroduction and hatchery supplementation actions.

Habitat Enhancement
Degradation of tributary habitat is a limiting factor for almost all chum salmon populations in the LCR -- although the nature and magnitude of this impact varies by location. Priority locations for chum habitat enhancement actions are based on biological needs and potential for benefits. Various methods can be used to protect and improve tributary habitat for chum salmon in the LCR tributaries. The following strategic approach is outlined in the FCRPS Biological Opinion proposed actions (Federal Action Agencies 2007).

The specific Objective, Strategy, and Actions for Habitat follows:

- **Objective** for All ESUs is to "Protect and improve tributary and estuary habitat to improve fish survival.
    - **Habitat Strategy 1:** Protect and improve tributary habitat based on biological needs and prioritized actions that address limiting factors identified for each ESU.
        - **Action:** Implement expanded tributary habitat program with particular (but not exclusive) focus on populations with greatest biological need (productivity less than 1) and where there is potential for improvement in tributary habitat. Proposed actions address key limiting factors to:
            - Increase streamflow through water acquisitions
            - Address entrainment through screening
            - Provide fish passage and access
            - Improve mainstem and side channel habitat conditions
            - Protect and enhance riparian conditions.
            - Improve water quality

Hatchery Supplementation

Chum populations at high risk of extinction can be preserved through artificial propagation safety-net programs until limiting factors can be addressed. Properly designed and implemented artificial propagation conservation programs can improve abundance, spatial structure, and diversity of natural spawning populations.

The specific Objective, Strategy, and Actions for Hatcheries follows:

- Objective for all ESUs: Fund FCRPS mitigation hatchery programs in a way that contributes to reversing the decline of downward-trending ESUs and DPSs.
    - **Hatchery Strategy 2:** Use safety-net and conservation hatchery programs to assist recovery of ESA-listed ESUs and Distinct Population Segments.
        - **Action for Columbia River Chum Salmon:** Fund assessment of habitat potential, development of reintroduction strategies, and implementation of pilot supplementation programs for chum salmon in selected LCR tributaries below Bonneville Dam.

WDFW is proposing the development of chum channels at selected sites as part of our reintroduction and supplementation approach. This proposal addresses the following criteria – under development by the Action Agencies and others – to rank implementation projects for 2010-2017:

- The project addresses the key limiting factors for chum salmon identified in the LCFRB recovery plan;
- The targeted chum salmon populations currently have low productivity;
- The projects will benefit more than one chum population within the chum ESU;
- The project will provide immediate benefits by increasing chum abundance;
- The VSP parameters will be considered and improvements made.

Although hatchery supplementation would target populations with low productivity, adequate adult chum abundance is needed to initiate a program. In cases where habitat quality is also very

limited, we need to combine other actions – such as instream habitat enhancements or the development of chum channels – in conjunction with a supplementation program.

Hatchery Scientific Review Group (HSRG) Recommendations
The HSRG recommends several small (100,000-200,000 fish programs) chum salmon conservation/supplementation hatchery programs. The goal of these programs would be to reduce demographic risk by boosting abundance and to preserve the genetic legacy of depressed chum salmon populations. The HSRG recommended conservation propagation programs be initiated within each of the ESU's three geographic strata.

Additionally, the HSRG recommends that the planning process should also include the development of a set of hypotheses regarding the likely causes of the decline of chum. Based on these hypotheses, the role and objectives of conservation hatcheries in a comprehensive recovery plan should be defined. Additional reintroduction or other conservation programs could then be considered based on monitoring and evaluation results. They also stated: Managers should avoid maintaining this ESU only through artificial propagation due to long-term hatchery risks of domestication and fitness loss.

LCFRB Recovery Plan (LCFRB 2004)
In Washington State, the Lower Columbia Fish Recovery Board (LCFRB) was established to develop and implement a recovery plan for ESA listed salmon and steelhead populations. In December 2004, the State of Washington submitted the LCFRB Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan to the National Oceanic and Atmospheric Administration (NOAA)–Fisheries to address the recovery of salmon and steelhead populations in this domain (LCFRB 2004). The goal of this plan is to "recover Washington lower Columbia salmon, steelhead, and bull trout to healthy, harvestable levels that will sustain productive sport, commercial, and tribal fisheries through the restoration and protection of ecosystems upon which they depend and implementation of supportive hatchery and harvest practices; and sustain and enhance the health of other native fish and wildlife species in the lower Columbia through protection of the ecosystems upon which they depend, control of non-native species, and the restoration of balanced predator/prey relationships" (LCRFB 2004).

The LCFRB plan (2004) focuses on recovery goals and strategies for salmon and steelhead populations in Washington LCR subbasins; however, because LCR salmon and steelhead ESUs include both Washington and Oregon populations, the plan included Oregon populations in the development of a recovery scenario. Utilizing the population structure and recommendations provided by the Lower Columbia/Willamette TRT, populations are designated as 1) primary – those to be restored to a high viability level, 2) contributing – those to be restored to a medium viability level , or 3) stabilizing – those to be maintained at current viability levels (LCFRB 2004). ODFW is currently working on recovery plan for Oregon salmon and steelhead populations. Table 4 outlines population recovery designations for LCR chum salmon populations. The WDFW worked with LCFRB staff in the development of the Recovery Plan and has endorsed its use as the primary strategy for recovery efforts in Washington LCR subbasins. Guided by population recovery designations, the LCFRB plan outlined recovery goals based on Viable Salmonid Population (VSP) parameters (McElhany 2000) for LCR salmon and steelhead populations. Abundance goals for LCR chum salmon are presented in Table 5.

Table 5: Recovery Goals for Lower Columbia River Chum Salmon Populations – from LCFRB Recovery Plan (2004).

	Scenario	Viability		Abundance			
Population	**contrib.**	**Current**	**Goal**	**Current**	**Viable**	**Potential**	**Goal**
Coast							
Grays/Chinook	Primary	Low+	High+	960	4,300	7,800	6,000
Eloch/Skam	Primary	Low	High	<150	1,100	8,200	1,100
Mill/Ab/Germ	Primary	V Low	High	<150	1,100	3,000	1,100
Youngs (OR)	Primary	na	High	na	1,100	2,200	na
Big Creek (OR)	Contributing	na	Low	na	1,100	2,200	na
Clatskanie (OR)	Contributing	na	Med	na	1,100	2,200	na
Scappoose (OR)	Contributing	na	Low	na	1,100	2,200	na
Cascade							
Cowlitz	Contributing	V Low	Med	<150	1,100	135,700	600
Kalama	Contributing	V Low	Low	<150	1,100	12,200	150
Lewis	Primary	V Low	High	<150	1,100	71,000	1,100
Salmon	Stabilizing	V Low	V Low	<150	1,100	4,200	75
Washougal	Primary	Low	High+	<150	1,100	9,400	5,200
Clackamas (OR)	Contributing	na	Med	na	1,100	2,200	na
Sandy (OR)	Primary	na	High	na	1,100	2,200	na
Gorge							
Lower Gorge	Primary	Med+	High+	542	2,600	3,100	2,800
Upper Gorge	Contributing	V Low	Med	<100	1,100	5,900	600

D. Relationships to other projects

WDFW Restoration Efforts

Response to the federal ESA listing has been primarily through direct-recovery actions: reducing harvest, hatchery supplementation using local broodstock for populations at catastrophic risk, habitat restoration (including construction of spawning channels) and flow agreements to protect spawning and rearing areas. Both state and federal agencies have built controlled spawning areas. In 1998, the WDFW began a chum salmon supplementation program using native stock on the Grays River. This program has continued through 2007, but is currently unfunded. In 2001, WDFW and the PSMFC received Bonneville Power Administration (BPA) funding (project # 2001-053-00) to construct/restore spawning channels in Duncan Creek and evaluate two reintroduction strategies, recolonization of the channels through release of adult spawners into the channels, and direct plants of hatchery reared fed-fry released at the mouth of Duncan Creek, and natural recolonization via straying. This project is on going; however, budget reductions in FFY08 eliminated the hatchery release component of the project. Results from the Duncan Creek project are intended to help guide reintroduction strategies in other Lower Columbia areas.

Table 6. Relationship to existing projects

Funding Source	Project #	Project Title	Relationship (brief)
BPA	199900301	Evaluate Spawning of Fall Chinook and Chum Salmon Just Below the Four Lowermost Columbia River Mainstem Dams	Project provides biological and population data for chum salmon spawning below Bonneville Dam, primarily the Ives Island area. This project will be incorporated into population M&E plan developed in this proposal for implementation in FFY 2010.
BPA	200105300	Reintro Of Chum In Duncan Cr	Project provides biological and population data for chum salmon spawning in areas outside of the Ives Island area. Provides data on three supplementation strategies (direct adult plants, fed-fry releases and natural recolonization). This project will be incorporated into population M&E plan developed in this proposal for implementation in FFY 2010.
BPA	200301000	Historic Habitat Opportunities and Food-Web Linkages of Juvenile Salmon in the Columbia River Estuary and Their Implications for Managing River Flows and Restoring Estuarine Habitat	Provides juvenile production estimates for a naturally spawning population of LCR chum salmon. Juvenile monitoring component of this project may be incorporated into population M&E plan developed in this proposal for implementation in FFY 2010.

E. Project history (for ongoing projects)

New Project

F. Proposal biological/physical objectives, work elements, methods, and metrics

Objective 1: Habitat restoration and chum channel site assessment.

Utilize the LCFRB Recovery Plan, existing stream habitat assessments and restoration project lists to develop a prioritized list of habitat restoration projects and/or locations within the LCR that would be the most beneficial to chum salmon.

Review available existing plans and habitat assessments, completed by Dec, 2009.

The criteria/metrics that will be used for ranking habitat restoration and chum channel locations will be finalized prior to assessment, but should consider the following:

1. Population recovery designation for affected chum salmon population - "primary" or "core" designations (LCFRB and Lower Columbia/Willamette TRT, respectively; (Table 4) should be given priority.
2. Quantity/quality of restored habitat provided.
3. Life history stage(s) benefitted.
   3.1. Is creation of spawning habitat part of the project?
   3.2. What level of spawner abundance will be supported?
4. Documentation of current or historic spawning in the location.
   4.1. Is or was the location used by chum salmon?
5. Feasibility/Risk Assessment.
   5.1. How likely is it that the project will be successful?
   5.2. How stable is the location?
   5.3. Build on LCFRB work group and other assessments where available.
6. Cost – if estimates are available.
   6.1. Utilize LCFRB and other project lists where available.

Generate a prioritized list of potential habitat restoration projects and chum spawning channel sites in Washington LCR tributaries describing the benefits of each, completed by Feb 2010.

Objective 2: Lower Columbia River chum salmon stock status review.

An updated stock status review of LCR chum salmon, population structure (genetic) and relationship (genetic) and abundance is critical to identifying and prioritizing where restoration actions will be most beneficial, what type of supplementation or reintroduction strategy is appropriate, and identifying potential donor stocks for these programs.

1) Analysis of genetic tissue and otolith samples collected in 2003-08, completed by end of project year one (est Feb 2010).

Genetics

Briefly: Genomic DNA will be extracted from tissues using a chelex resin protocol (Small et al. 1998). Microsatellite alleles at loci will be amplified using fluorescently labeled primers and the polymerase chain reaction (PCR). PCR's will be conducted on a MJResearch PTC-200 thermocycler in 10 µl volumes employing 1 µl template with final concentrations of 1.5 mM MgCl2 and 1X Promega PCR buffer. Samples will be run on an ABI 3730 automated sequencer and alleles sized (basepairs, bp) and binned using an internal lane size standard (GS500Liz from Applied Biosystems) and Genemapper software (Applied Biosystems). Statistical test /analysis likely to include but not limited to: Hardy-Weinberg Equilibrium and FIS, Genotypic Linkage Disequilibrium, Bottleneck tests and Ne, Allelic Data, MDS, Neighbor-Joining Tree and PCA Pairwise Genotypic Tests, Molecular Variance, Assignment Tests and STRUCTURE Analysis.

See attached file in PISCES LCchumFinalreport.doc "Genetic structure of chum salmon (Oncorhynchus keta) populations in the lower Columbia River: are chum salmon in Cascade tributaries remnant populations?" for complete details. Personnel in WDFW's Genetics Lab will perform this work. This report will update and expand our existing knowledge of chum

salmon genetic structure and relationships in the lower Columbia River. The results of this analysis will be used to guide appropriate stock selection for future chum salmon reintroduction and or supplementation programs.

Otoliths

WDFW's otolith lab will complete examination (decoding) of all otoliths from LCR chum salmon collected between 2002 and 2008 that are currently archived (approximately 734 samples). Identification of supplementation-origin adults will be done by decoding otoliths for thermal marks (Volk et al 1999 and Brenkman et al 2007).

2) Review and update of historic and recent chum salmon abundance data, completed by end of project year one (est Feb 2010).

Complete an analysis of recent and historical (covering at least the period of 2000-2008) LCR chum salmon abundance. This will include complete and final estimates for 2008 LCR chum salmon spawner abundance. In addition, work will be done to correct historical abundance data with the current best available methods/analysis/science.

WDFW has been conducting in-depth population monitoring using Jolly-Seber mark-recapture methodology (Jolly 1965 and Seber 1965) in conjunction with the typical methodologies used historically (Area-Under-the-Curve (English et al. 1992), peak counts and peak count expansion) on chum salmon spawning in the Grays River, Columbia River mainstem spawning areas and tributaries near Bonneville Dam for several years now. A detailed description of methodologies can be found in Rawding and Hillson (2003) and Rawding et al. (2006). The task to be completed for these recent monitoring efforts include model selection and assumption testing (closure/emigration, tag effects, and equal catchability) all LCR chum salmon spawning populations. Once this is completed, along with the concurrent methodologies, WDFW will be able to estimate observer efficiency, peak count expansion factors, distribution, and apparent residence time along with their associated variances, which can be applied to other populations where less intensive monitoring has occurred to generate statistically based population estimates that include estimates of precision. This analysis will allow us to incorporate the best available science in developing historical population estimates so that more informed decisions regarding supplementation and reintroduction recommendations.

3) Review of existing supplementation programs (i.e. Grays River and Duncan Creek) – determine the contribution of supplementation programs to the natural spawning population, completed by end of project year one (est Feb 2010).

Using the spawner population estimates and otolith decoding data, determine the contribution of the Duncan Creek and Grays River supplementation programs to the natural spawning populations in all applicable years. Also, generate fry-to-adult survival rates for chum salmon released from Grays River Hatchery.

4) Review of recovery strategies outlined in the LCFRB's Recovery Plan (2004), the FCRPS Biological Opinion and coordination with other relevant management entities, completed by Feb 2010.

Objective 3: Develop a supplementation/reintroduction strategy for LCR chum salmon.

As exemplified by the Grays River hatchery program (described previously in Section B and below in Objective 5 of this narrative), conservation level hatchery supplementation programs can be utilized to buffer populations against catastrophic risk. As habitat restoration and other recovery efforts for depressed LCR chum populations move forward, supplementation of remnant populations or reintroduction of extant populations can also be an effective tool in jump-starting recovery and utilization of newly restored/created habitat. The BPA funded Duncan Creek reintroduction project (#2001-053-00) is an example of the latter. Results from this on-going project will help to direct future supplementation strategy development. A detailed M&E plan for Duncan Creek reintroduction strategies has been developed (Schroeder 2000) and will provide a useful template for future programs.

Stream surveys conducted by WDFW and PSMFC staff in recent years have documented low-level chum spawning activity in many of Washington States' LCR tributaries. Spring-fed seeps and upwelling areas were identified during these surveys; genetic tissue and otolith samples were collected from chum salmon carcasses in these locations (Table 3). The proposed stock status review (Objective 2), to be completed as part of this project, is intended to provide updated information on genetic structure useful in further determining if chum spawning in these areas are genetically distinct remnant populations or extensions of larger neighboring populations. Otolith analysis will be used to detect straying from the Grays River or Duncan Creek supplementation programs.

We propose to develop a strategy that incorporates population recovery designations (Table 5), updated genetic and abundance information and potential habitat restoration/chum channel projects in identifying 1) priority populations for supplementation/reintroduction, 2) preferred methods of supplementation/reintroduction for these populations, and 3) the genetic stock source (donor stock) for each.

This plan will tie together the recommendations made for habitat restoration and chum channel projects (results of PISCES Work Element C) with results and recommendations from PISCES Work Element C, Milestones D (identification of stock source), F (historical and current status of priority populations) and G (suitable reintroduction/supplementation methods) to chum salmon populations identified in Table 4 of this narrative. It will include rankings and timelines for implementation. A draft of this plan will be completed by Feb 2010.

Objective 4: Population monitoring and evaluation program development.

A well-developed population M&E program for LCR chum salmon should address three needs associated with recovery actions:

1) Biological monitoring necessary to assess stock status via VSP parameters associated with ESA listing and potential de-listing criteria.

2) Biological monitoring to provide an adaptive management feedback loop to improve ongoing and future supplementation/reintroduction programs.

3) Effectiveness monitoring to provide an adaptive management feedback loop to improve ongoing and future habitat restoration actions.

Adult chum salmon abundance monitoring via stream surveying is occurring in the Grays and Cowlitz Rivers, Mill, Abernathy, and Germany (MAG) creeks, and for the Lower Gorge population(s) (Washington tributaries and mainstem Columbia River spawning areas between the I-205 Bridge and Bonneville Dam) (Table 7). Monitoring for Upper Gorge populations occurs via counts made at Bonneville Dam fish counting stations.

Monitoring for the Grays River, MAG creeks, and Lower Gorge population utilizes a combination of Area-Under-the-Curve (AUC) (English et al. 1992), and Jolly-Seber (JS) mark-recapture (Jolly 1965 and Seber 1965) methodologies to develop accurate and precise estimates of total abundance. A detailed description of methodologies can be found in Rawding and Hillson (2003) and Rawding et al. (2006).

Currently, for most LCR salmon and steelhead populations, monitoring is directed at addressing stock status. For LCR chum salmon, the supplementation programs on the Grays River and reintroduction at Duncan Creek have prompted increased monitoring for these populations. As future habitat restoration projects and supplementation programs are implemented, the need for a coordinated M&E program will increase.

Since ESU status is a role up of individual population status, all adult chum salmon populations within the ESU must be monitored; however, the level of monitoring for each population is not likely to be equal. Populations designated as primary by the LCFRB (Table 4) are likely to be required to be monitored more intensively than contributing or stabilizing populations. As supplementation/ reintroduction programs are implemented monitoring needs may change and adaptive management will be required.

For biological monitoring, there should be negligible bias in population estimates and the level of precision should be consistent with the management or recovery goals. Probably the most cited work for precision is over 40 years old. Robson and Reiger (1964) assumed a value of $\alpha = 0.05$ and recommend various levels of precision based on the purpose of data collection. They recommend 95% Confidence Intervals (CI) of less than + 10% of the point estimate for research into population dynamics, which may also be reasonable for some aspects of hatchery, habitat, harvest, and hydro effectiveness monitoring. For accurate management they advocated 95% CI that are less than ± 25% of the point estimate, which may correspond to the desired level for status and trends monitoring. For preliminary studies or for rough population estimates, they indicate the 95% CI intervals that are less than ± 50% of the point estimates were acceptable. Cousens et al. (1982) defined monitoring programs with 95% CI less than +20% of the point estimate as good.

Depending on the desired precision goal, sample design development can utilize a variety of methodologies including census counts, mark-recapture via live fish or carcass tagging, Area-Under-the-Curve from live counts, peak count expansion, sonar, redd counts, and other methods. In general, sampling designs for higher levels of precision are more complex and costly. Figure 1 is a representation between cost of monitoring and accuracy of the monitoring.

Table 7. Current and proposed adult chum salmon abundance monitoring locations, methods and funding source.

		FFY 2009		FFY 2010	
Washington Populations	**LCFRB Recovery Designation**	**Current Method(s)**	**Current Funding**	**Proposed Method(s)**	**Proposed Funding**
Coast Stratum					
Grays (Grays/Chinook)	Primary	JS, AUC_C	SRFB	W, JS, AUC_C	SRFB
Chinook (Grays/Chinook)	X	NS		AUC_C	BPA
Elochoman (Eloch/Skam)	Primary	NS		JS, AUC_C	BPA
Skamokawa (Eloch/Skam)	Primary	NS		AUC_C	BPA
Mill/Abernathy/Germany	Primary	AUC-C	SRFB	AUC_C	SRFB/BPA
Cascade Stratum					
Cowlitz	Contributing	SP	WDFW	MP, AUC_I	BPA
Coweeman (Cowlitz Trib)	X	NS		MP, AUC_I	BPA
SF Toutle (Cowlitz Trib)	X	NS		MP, AUC_I	BPA
NF Toutle (Cowlitz Trib)	X	NS		MP, AUC_I	BPA
Green (Cowlitz Trib)	X	NS		MP, AUC_I	BPA
Kalama	Contributing	NS		MP, AUC_I	BPA
Lewis (EF and NF)	Primary	NS		AUC_C	BPA
Salmon	Stabilizing	NS		MP, R_PS	BPA
Washougal	Primary	NS		JS, AUC_C	BPA
Gorge Stratum					
Lower Gorge Tribs./mainstem Columbia	Primary	JS, AUC_C	BPA	JS, AUC_C	BPA
Upper Gorge Tribs.	Contributing	W	USACE	W	USACE

Abbreviation	**Definition**
W	Weir
JS	Jolly-Seber Mark-Recapture
AUC_C	Area-Under-the-Curve w/ census of spawning distribution
AUC_I	Area-Under-the-Curve w/ index sampling expanded for historical index use
SP	Single Pass count of redds, deads, lives
MP	Multiple Pass count of redds, deads, lives
R_PS	Redd Count w/ Probablilistic Sampling
X	Part of Larger Population
NS	No Surveys directed at chum monitoring
BPA	Bonneville Power Administration
SRFB	Salmon Recovery Funding Board (Washington State)
USACE	US Army Corp of Engineers - Bonneville Dam Counts

We propose to develop a comprehensive M&E program for LCR chum populations that incorporates biological monitoring (for adult spawners and juvenile outmigrants) commensurate with their recovery designation, while addressing monitoring needs associated with implementation of supplementation/reintroduction programs and habitat restoration actions. Table 7 outlines one potential strategy to evaluate for future adult abundance monitoring. Future juvenile monitoring will be proposed for at least one primary population per stratum (LCFRB 2004). A draft of this framework/plan will be completed and available for review by end of year one (est Feb 2010). Initial implementation of the framework/plan in would occur in fall 2010, with a final plan completed and implemented beginning fall of 2011.

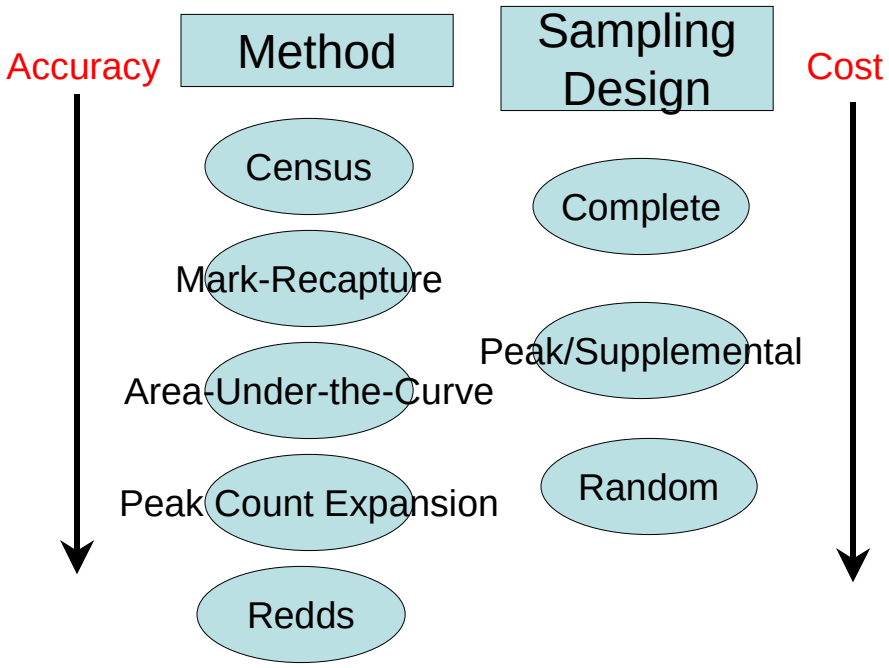

Figure 1. Generalization of trade offs between accuracy and cost of monitoring programs including the methods used to estimate abundance and the spatial sampling design.

Objective 5: Grays River chum salmon supplementation.

Infrastructure, staffing, and permitting are in place to continue this supplementation project without interruption. This program buffers catastrophic risk to the Grays River chum population and will become more important if Grays River chum are used as the donor stock for other LCR supplementation/reintroduction programs in the future.

The Grays River program was modeled on, and developed under, the guiding standards of successful chum salmon supplementation programs implemented in the Puget Sound and Hood Cannel (WDFW and PNPTT 2000, Ames and Adicks 2003, Johnson et al. 2003). Broodstock from returning chum salmon are collected in the fall from the mainstem, West Fork Grays River and Crazy Johnson Creek. Spawning is conducted at WDFW's Grays River Hatchery (located on the WF Grays River), where eggs are incubated and hatched. Fry are thermally marked (Volk, E.C., S.L. Schroder, and J.J. Grimm. 1999) and released in the spring of the following year. Specific details of the program are described in the Draft Grays River Chum Salmon Hatchery & Genetic Management Plan (HGMP) submitted to NMFS (WDFW 2004a), a copy is attached to this project in PISCES.

In FFY 2009, we propose to avoid interruption of the on-going Grays River chum salmon supplementation program by capturing broodstock, with the goal of collecting 100,000 to 200,000 eggs (40 to 80 adult pairs spawned). As part of the aforementioned stock status review, contribution of supplementation program releases to the natural spawning population will be assessed through analysis of otolith and DNA samples. In addition, a 3-step review for the program will be initiated through the NPCC process, completion by the start of the 2009 broodstock collection season.

Objective 6: Removal of invasive vegetation in Hamilton Spring Channel.

Hamilton Spring channel is one of only two (Duncan Creek spawning channels being the other) protected off-channel chum salmon spawning areas in the Bonneville area. Non-native vegetation (reed canary grass and Himalayan blackberry) has encroached into the spawning channel to the extent that it is reducing the amount of available spawning area. In addition, the canary reed grass captures fine sediments instead of letting them flush from the area thus reducing the quality of the spawning gravel.

To remedy this, we propose to remove the canary reed grass from the spawning channel graveled/watered areas. Removal will be done by hand using hand tools only. Work will be completed by Sept 2009.

Objective 7: Initiate 3 Step review for at least one top ranked project identified by the habitat restoration and chum channel site assessment.

Initiate a Council 3-Step review for at least one supplementation/reintroduction project that was identified in the draft supplementation/reintroduction strategy plan produced under Section F Objective 3 of this narrative and PISCES Work Element J.

G. Monitoring and evaluation

The monitoring and evaluation of Objectives 1-4 and 7 will be accomplished via implementation/compliance monitoring. A document will be produced that reports on our success at meeting the timelines and deliverables, mainly assessments and draft plans in FFY09, identified in our statement of work and PISCES. This document can be expanded upon in future years to include project/action implementation and success.

Assessments and draft plans that will be completed in this contracts time period.

1. Habitat restoration and chum channel site assessment.
2. Lower Columbia River chum salmon stock status review.
3. Supplementation/reintroduction strategy for Lower Columbia River chum salmon.
4. Lower Columbia River chum salmon population monitoring and evaluation framework/plan.

A complete narrative of the monitoring and evaluation plan for the Grays River supplementation part of this proposal (Section F, Objective 5) can be found in Section 11 (Monitoring and Evaluation of Performance Indicators of the Grays River HGMP (submitted and acknowledged by NOAA in 2004)). In summary, sufficient numbers of adults are collected to ensure a viable population size (> 40 pairs) and spawned using a factorial matrix. Adults are collected from spawning areas with the known lowest percent of hatchery origin spawners to reduce domestication effects and are collected proportionally to maintain run timing. Survival metrics such as fecundity, green-to-eyed-egg survival, eyed-egg-to-hatch, hatched-to-swim-up and ponded-to-release survival rates are measured and expected to be near 90%. All fry are released as fed-fry (50-55mm in length and 1.0-1.5 grams in weight) and thermally marked so that they

can be correctly identified when recovered to allow for fry-to-adult survival estimation and percent hatchery origin on the spawning grounds.

A robust annual spawner estimate has been conducted in the Grays River basin since 2004 via carcass tagging (Jolly-Seber methodology including assumption testing) as well as spawner live/dead/redd counts. Carcass tagging marking rates are set to achieve a precision goal of having the 95% CI being <10% of the point estimate. Otoliths and DNA samples are collected from all adults spawned at the hatchery and a representative sample from adults recovered on the spawning grounds (around 600 otoliths and 100 DNA samples annually) to assess the impacts/contribution of the supplementation program. Results will be reported in a form that will be determined under Objectives 3 and 4 of this proposal.

The proposed vegetation removal in Hamilton spring channel (Section F, Objective 6) will be evaluated by comparing the pre- and post-treatment percent of open spawning area/gravel. The pre-treatment condition will be documented by determining the percent of total wetted area within the spawning channel that is covered by vegetation. A post-treatment survey will be done and the change in percent area covered will be used to measure the success. The total wetted spawning area and areas covered by vegetation will be recorded using a GeoExplorer CE series Trimble GPS unit. Data points will be used to create shape-files in ArcGIS software that will allow pre- and post-treatment comparisons to be made.

H. Facilities and equipment

Personnel working on this project have office space at either the WDFW Region 5 office or at the WDFW headquarters in Olympia. Respective labs, also located in WDFW headquarters in Olympia, will do DNA analysis and otolith decoding. All spawning, incubation and rearing related to Grays River supplementation will take place at WDFW's Grays River Hatchery. Vehicles used will be either from the Washington State motor pool or GSA.

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J. Key personnel

Bryce Glaser – WDFW Fish Biologist 4 – Region 5 Anadromous Fish/ESA Unit Lead
Todd Hillson – WDFW Fish Biologist 3 – Region 5 Anadromous Fish/ESA Unit
Daniel Rawding – WDFW Natural Resource Scientist – Stock Assessment Unit
Steve Schroder – WDFW Research Scientist – Ecological Investigations Unit Lead
Maureen Small – WDFW Fisheries Geneticist – Conservation Biology Unit
Steve Vigg – WDFW Fish Manager, Region 5

Bryce Glaser

EDUCATION:

B.S. in General Biology from University of Hawaii at Manoa (1992)

RECENT PREVIOUS EMPLOYMENT:
2006 – Present Fish Biologist 4, WDFW, Southwest Region (5), Vancouver , WA.
2002 – 2006 Fish Biologist 3, WDFW, Southwest Region (5), Vancouver , WA.
1999 – 2002 Fish Biologist 2, WDFW, Southwest Region (5), Vancouver , WA.
1995 – 1999 Oceanographic Research Assistant, U. of Hawaii at Manoa, HI.
1993 – 1995 Scientific/Fisheries Technician, WDW & WDF, Southwest, WA.

CURRENT RESPONSIBILITIES -Lead biologist for the Region 5 Anadromous Fish/ ESA Unit, including wild salmon and steelhead monitoring and recovery planning/ implementation efforts in the Lower Columbia River.

EXPERTISE -Eight years experience directly related to monitoring and managing steelhead and salmon populations including, utilizing mark-recapture, Area-Under-the-Curve, and redd count expansion methodologies for adult and juvenile abundance monitoring; supervising field crews and participating in field work to accomplish the above.

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Rawding, D., T. Hillson, B. Glaser, K. Jenkins, and S. VanderPloeg. 2006. Abundance and Spawning Distribution of Chinook Salmon in Mill, Abernathy, and Germany Creeks during 2005. Wash. Dept. of Fish and Wild. Vancouver, WA. 37pp.

Sharpe, C. S., and B. Glaser. 2005 Coweeman River Juvenile Salmonid Production Evaluation. Completion report to WDFW 30pp.

Todd Hillson

EDUCATION

B.S. Wildlife Science, Oregon State University, 1988

RECENT PREVIOUS EMPLOYMENT

2001 – present Washington Department of Fish and Wildlife, Fisheries Biologist 3
1996 – 2000 Washington Department of Fish and Wildlife, Fisheries Biologist 2

CURRENT RESPONSIBILITIES – Region 5 chum salmon biologist, Anadromous Fish/ ESA Unit. Project lead for WDFW's portion of the Historic Habitat Opportunities and Food-Web Linkages of Juvenile Salmon in the Columbia River Estuary and Their Implications for Managing River Flows and Restoring Estuarine Habitat (BPA Project # 200301000). Project lead for the Reintroduction of Chum salmon into Duncan Creek (BPA Project # 200105300). Project lead for WDFW's adult salmonid weir operations on the Grays River.

EXPERTISE – 18 years of fisheries research involving salmonids and two years of salmonid aquaculture. Work experience includes seven years conducting smolt monitoring at mainstem Columbia and Snake River hydropower facilities. Four years as the Lewis River Hatchery evaluation biologist conducting research relating hatchery operations/conditions to return rates of adult salmonids. Seven years of conducting mark/recapture experiments (Jolly-Seber model) to estimate adult salmonid populations. Nine years of experience conducting smolt trapping in both large and small streams using rotary screw traps and fence-panel weirs.

SELECTED PUBLICATIONS

Hillson, T. D. and Rawding, D. 2004. Reintroduction of Lower Columbia River Chum Salmon into Duncan Creek (BPA Project No. 200105300) Council 3-Step Review.

Hillson, T. D. In Prep. Re-Introduction of Lower Columbia River Chum Salmon into Duncan Creek Annual Report for 2008, Report to Bonneville Power Administration, Contract No. 00007373, Project No. 200105300.

Rawding, D. and T. D. Hillson. 2002. Population estimates for chum salmon spawning in the Mainstem Columbia River, 2002. Project 2001-05300, 47 electronic pages, (BPA Report DOE/BP-00007373-3).

Rawding, D., T. Hillson, B. Glaser, K. Jenkins, and S. VanderPloeg. 2006. Abundance and Spawning Distribution of Chinook Salmon in Mill, Abernathy, and Germany Creeks during 2005. Wash. Dept. of Fish and Wild. Vancouver, WA. 37pp

Rawding, D. and T. D. Hillson. 2008. Population estimates for chum salmon spawning in the Mainstem Columbia River, 2008. Project 2001-05300. In Prep

Daniel John Rawding

Education: B.S. Fishery Science from University of Washington, 1982
M.S. Environmental Science Washington State University, expected graduation 2009

Recent Employment: 1983-Present; Natural Resource Scientist 3, Washington Department of Fish and Wildlife

Current Responsibilities: Mr. Rawding is the lead agency scientist for statewide adult salmon and steelhead population monitoring. His current focus is the development and implementation of cost-effective adult salmon monitoring programs to meet regional goals. He currently represents WDFW in regional monitoring forums including the NOAA's Willamette Lower Columbia River Technical Recovery Team, the Sentinel Stocks Committee of the Pacific Salmon Treaty, and the Lower Columbia River Science Team.

Expertise: Mr. Rawding has over 25 years of salmon and steelhead fisheries, hatchery, and population monitoring including adaptation of different methodologies to estimate adult salmon and steelhead populations, development viability criteria for salmon and steelhead populations, fisheries risk assessment using spawner-recruit analysis, application of the Ecosystem Diagnosis and Treatment model to over 50 Lower Columbia River salmon and steelhead populations, hatchery risk assessments, selected review of Columbia Basin salmon and steelhead monitoring programs, and chapter author for subbasin plans. His specific areas of interest are: population dynamics and viability of salmon and steelhead populations, capture-mark-recapture methods, Bayesian methods for estimating abundance and survival, and the development of cost-effective population monitoring programs.

Selected Publications:

Rawding, D. 2007. A Preliminary Review of Steelhead Populations Monitoring Programs in the Washington Portion of the Snake and Middle Columbia River Evolutionary Significant Units. Washington Department of Fish and Wildlife. Olympia, WA. 51 pages

Rawding, D., T. Hillson, B. Glaser, K. Jenkins, and S. VanderPloeg. 2006. Abundance and Spawning Distribution of Chinook Salmon in Mill, Abernathy, and Germany Creeks during 2005. Wash. Dept. of Fish and Wild. Vancouver, WA. 37pp

Rawding. D. and P.C. Cochran. 2005. Wind River Winter and Summer Steelhead Adult and Smolt Population Estimates from Trapping Data, 2000 – 2004. Report to Bonneville Power Administration, Contract # 199801900, 33 electronic pages.

Rawding, D. and T. D. Hillson. 2003. Population estimates for chum salmon spawning in the Mainstem Columbia River, 2002. Project 2001-05300, 47 electronic pages, (BPA Report DOE/BP-00007373-3) http://www.efw.bpa.gov/Publications/A00007373-3.pdf

McElhaney, P., T. Backman, C. Busack, S. Heppell, S. Kolmes, A. Maule, J. Meyers, D, Rawding, D. Shively, A. Steel, C. Steward, and T. Whitesel. 2003. Interim report on viability criteria for Willamette and Lower Columbia Basin Pacific Salmonids. NOAA-Fisheries. Northwest Fisheries Science Center. Seattle, WA.

Steven L. Schroder

EDUCATION

Ph.D. Fisheries Science. University of Washington
M.S. Fisheries Science. University of Washington
B.S. Fisheries Science. University of Washington

RECENT PREVIOUS EMPLOYMENT

1990-Present Fisheries Research Scientist II, Washington Department of Fish and Wildlife.

CURRENT RESPONSIBILITIES

Leader of the Ecological Investigations Unit in the Science Division, Fish Program, Washington Department of Fish & Wildlife. The Ecological Investigations Unit possesses five subgroups. One of these is WDFW's Otolith Laboratory which is responsible for thermally marking up to 50 million embryonic salmonids per year, examining otoliths for thermal marks, using micro-chemistry signals in otoliths to decipher natural life history events, and inducing and decoding strontium marks in salmonids and marine fishes. A Fish Aging subgroup produces all the age estimates for salmonids, marine, and freshwater fishes for WDFW. A third group investigates how to carry out selective fisheries on salmonids by evaluating the effects of various types of capture gear on the survival and reproductive success of salmonids. The fourth group, referred to as the Large Lakes Research Team, examines limiting factors and productivity of fishes in lakes throughout the state, while the fifth group is involved with the recovery of depressed or listed salmon stocks, investigates the effects of hatchery culture (e.g. domestication) and also evaluates the reproductive success of wild and hatchery origin salmonids.

EXPERTISE

Over 35 years of fisheries research experience that has ranged from evaluating the effects of biological and environmental factors on the survival and productivity of salmonid populations to inventing, testing, and using new marking methods (thermal marking and strontium marking) on salmonids and other fishes. Specific areas of interest are: reproductive ecology of salmonid fishes, gamete quality assessments of hatchery and wild salmonids, evaluating alternative salmonid fish cultural methods (incubation methods, feeding regimes, release strategies, modifications to rearing areas), developing and testing fish marking tools, examining juvenile salmon ecology in freshwater and estuarine areas, and recovery of depressed or ESA listed salmonids via habitat alterations and fish cultural methods. Has co-authored over 40 peer-reviewed journal articles, book chapters, and technical reports.

SELECTED PUBLICATIONS

Gaudemar, B., S.L. Schroder, and E.P. Beall. 2000. Nest placement and egg deposition in Atlantic salmon redds. Environmental Biology of Fishes 57: 37-47.

Knudsen, C.M., S.L. Schroder, C.A. Busack, M.V. Johnston, T.N. Pearsons, W.J. Bosch, and D.E. Fast. 2006. Comparison of life history traits between first-generation and wild upper Yakima River spring Chinook salmon. Transactions of the American Fisheries Society 135: 1130 – 1144.

Knudsen, C.M., S.L. Schroder, C.A. Busack, M.V. Johnston, T.N. Pearsons, and C.R. Strom. 2008. Comparison of female reproductive traits and progeny of first-generation hatchery and wild upper river spring Chinook salmon. Transactions of the American Fisheries Society 137: 1433-1445.

Schroder, S.L., C.M. Knudsen, T.N. Pearsons, T.W. Kassler, S.F. Young, C.A. Busack, and D.E. Fast. 2008. Breeding success of wild and first-generation hatchery female spring Chinook salmon spawning in an artificial stream. Transactions of the American Fisheries Society 137:1475-1489.

Volk, E.C., S.L. Schroder, and J.J. Grimm. 2005. Otolith thermal marking. Pages 447-463 *In* S.X. Cardin, K.D. Friedland, and J.R. Waldman (ed.s) Stock Identification Methods, Elsevier Press.

DR. MAUREEN P. SMALL

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Education

2001-02 Postdoctoral research at Idaho State University, Pocatello, ID
1998-99 Postdoctoral research at the National University of Ireland, Galway, Ireland
1995-97 Postdoctoral research at the Pacific Biological Station, Nanaimo, BC, Canada
1994 Ph. D. Zoology, Duke University, Durham, NC
1987 B. S. Botany, University of Washington, Seattle, WA

Current Employment

Fisheries Geneticist, Conservation Biology Unit, Washington Department of Fish and Wildlife

Research Experience

2007-08 Collaborative research on micro-evolutionary processes using the lizard *Urosaurus ornatus* as a model. Developed microsatellite loci and sequenced three mitochondrial regions in lizard populations inhabiting different environments. Coordinated genetic data with colleagues' behavioral and biological data to develop hypotheses for evolutionary processes.

2002-09 Research on salmonid population genetics at the Washington Department of Fish and Wildlife. I participate in and supervise development of nuclear and mitochondrial DNA loci for salmonid research, process and analyze DNA data, write up results for internal reports and for peer-reviewed journals, present results at local, regional and international meetings.

2001-02 Post-doctoral research on Arctic mammal population and species structure at Idaho State University. Developed microsatellite DNA markers for screening marten populations and subspecies, trained undergraduate and graduate students in DNA extraction, PCR, cycle sequencing, PCR and sequencing product cleanup, analyzed fluorescent microsatellite data and wrote up results for publication.

1998-99 Post-doctoral research on littorinid snail population structure and speciation at National University of Ireland, Galway. Collected samples, developed a non-radioactive SSCP analysis system and performed genetic analysis of littorinid snail species, analyzed and published results.

1995-97 Post-doctoral research on coho salmon population genetics, helped develop non-radioactive microsatellite DNA analysis protocol, screened a chinook library and developed microsatellite loci for use in analyzing coho salmon population structure, supervised two technicians, analyzed and wrote up data for publication.

Publications

In Press Small, M.P., K. Currens, T. H. Johnson, A. E. Frye and J. F.Von Bargen. Impacts of supplementation: Genetic diversity in supplemented and unsupplemented populations of summer chum salmon in Puget Sound. Canadian Journal of Fisheries and Aquatic Science

2007 Small, MP, McLellan, J, Loxterman, J, Von Bargen, JF, Frye, AE, and C. Bowman. Fine-scale population structure of rainbow trout (*Oncorhynchus mykiss*) in the Spokane River drainage in relation to hatchery stocking and barriers. Transactions of the American Fisheries Association 136(2):301-317.

2006 Small, MP, Pichahchy, AE, Von Bargen, JF and SF Young. Genetic structure of chum salmon (*Oncorhynchus keta*) populations in the lower Columbia River: are chum salmon in Cascade tributaries remnant populations? Conservation Genetics 7(1): 65-78.

2005 Small, MP, Loxterman, JL, Pichahchy, AE, Von Bargen, JF and SF Young. Temporal and spatial genetic structure among Pacific herring (*Clupea pallasi*) populations in Puget Sound and Strait of Georgia. Transactions of the American Fisheries Association 134(5):1329-1341.

2004 Small, MP, Pichahchy, AE, Von Bargen, JF, and SF Young. Have native coho salmon (*Oncorhynchus kisutch*) persisted in the Nooksack and Samish rivers despite continuous hatchery production throughout the past century? Conservation Genetics, 5:367-379.

Steven C. Vigg

EDUCATION:

1971-73 **B.S.** in Fisheries, Humboldt State Univ., Arcata, CA (GPA= 3.42)

1974-75 **M.S.** in Natural Resources, Humboldt State Univ., Arcata, CA (GPA= 3.88)

1979-84 Post-Graduate level Biology courses; University of Nevada, Reno, NV (82 Semester Units - GPA= 3.57)

1986 Ph.D. program coursework in fisheries and quantitative science; University of Washington, Seattle, WA (52 Quarter Units - GPA= 3.71)

EXPERTISE

- Columbia River Basin Anadromous and Resident Fish Plans & Enhancement
- FCRPS – Restoration Strategies – to Protect, Mitigate & Enhance Fish & Wildlife
- Effects of Fish Predation on Out-Migrating Juvenile salmonids
- State, Federal, and Tribal Fisheries Management in the Columbia Basin
- Columbia Basin Conservation Enforcement as a Fish Restoration Strategy
- Endangered Species Act – Fish Recovery Strategies and Compliance
- FERC – Fish Re-introduction Strategies and Compliance
- Business Acumen – Personnel and Project Management & Budget

CURRENT RESPONSIBILITIES:

02/2006 to Present: Washington Department of Fish & Wildlife; Region 5 Fish Management Harvest Manager, WMS-2; Fish Program –Vancouver, Washington:
Full responsibility to manage and implement the Fish Management staff and activities in Southwest Washington and Lower Columbia River. These activities include managing the fish resources in the lakes and streams within the region to ensure healthy and diverse populations while maximizing sport and commercial fishing opportunities. This position manages a staff of 36 full time and 102 career seasonal and temporary employees with an annual operating budget of $4 million. Key duties include: (1) Manage and direct the fisheries assessment and management activities within Region 5; (2) Ensure staff ESA compliance and recovery efforts -- federal and state programs (3) Lead cross program coordination between other Divisions and Programs within Region; (4) Manage Fish Management Budget.

PREVIOUS EXPERIENCE:

10/1998 to 02-2006: **Owned and operated an independent Natural resources Consulting Company – Steven Vigg & Company (Subchapter S Corporation)**
6/1995 to 10/1998: **Senior Consultant for S.P. Cramer & Associates, Inc.**
12/1990 to 6/1995: **Fishery Biologist (Management) for Bonneville Power Admin.**
07/1988 to 12/1990: **Supervisory Fish & Wildlife Biologist for Oregon Dept. F&W**
07/1984 to 07/1988: **Fishery Biologist U.S. Fish and Wildlife Service; Columbia River Research Station, Cook, WA**