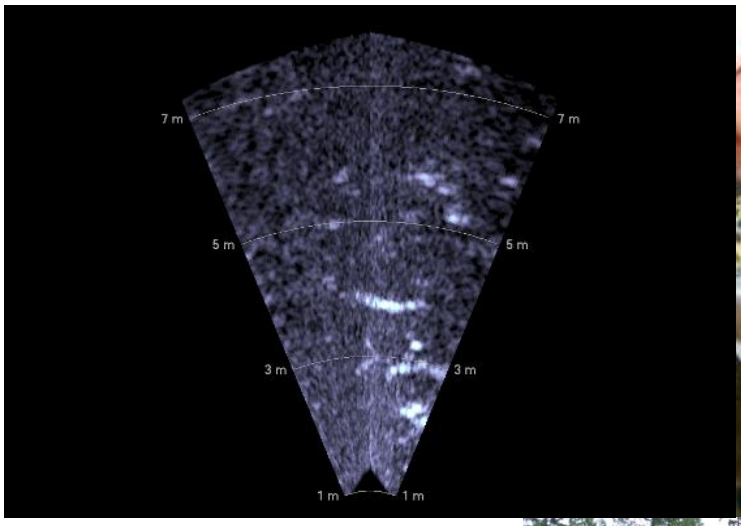
Methods and Quality of VSP Monitoring Of ESA Listed Puget Sound Salmon and Steelhead

With Identified Critical Gaps

2012



Produced By The Puget Sound Ecosystem Monitoring Program's Salmonid Work Group

Edited By Bruce A. Crawford

National Marine Fisheries Service - Northwest Region

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PUGET SOUND ECOSYSTEM MONITORING PROGRAM

United States Environmental Protection Agency

About PSEMP

The Puget Sound Ecosystem Monitoring Program (PSEMP) is a collaboration of monitoring professionals, researchers, and data users from state, federal, tribal, local government agencies, watershed groups, businesses, and private and volunteer groups.

The objective of PSEMP is to create and support a collaborative, inclusive, and transparent approach to regional monitoring and assessment that builds upon and facilitates communication among the many monitoring programs and efforts operating in Puget Sound. PSEMP's fundamental goal is to assess progress towards the recovery of the health of Puget Sound.

The Salmonid Workgroup is one of several technical workgroups operating under the PSEMP umbrella – with a specific focus on the life history monitoring of Puget Sound salmonids including salmon, steelhead, bull trout, and coastal cutthroat and the monitoring of the habitat upon which they rely. This includes the ESA listing factors such as habitat limiting factors, the monitoring of harvest programs, hatchery influences, climate, predation, and regulatory actions. For more information about PSEMP and the Salmonid Workgroup, please visit: https://sites.google.com/a/psemp.org/psemp/.

Cover photos:
Elwha River Sonar salmon image courtesy of Keith Denton, NOAA's Northwest Fisheries Science Center; Rainbow trout courtesy of Washington Recreation and Conservation Office;
Nisqually River adult collection weir, courtesy of Nisqually Tribe

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EXECUTIVE SUMMARY

The Puget Sound Partnership is leading efforts to develop and implement the Puget Sound Ecosystem Monitoring Program (PSEMP). PSEMP is designed to leverage existing monitoring to support data collection, management, analysis, and reporting. PSEMP functions to identify monitoring gaps and proposes new monitoring to address gaps. The Federal Caucus approved this assessment of monitoring of viable salmonid population (VSP) criteria to determine the quality of listed salmon and steelhead population abundance, productivity, distribution, and diversity estimates and protocols. Funding was provided through a U.S. Environmental Protection Agency and National Marine Fisheries Service interagency agreement.

Fifteen sub-regional meetings were held in 2011 with tribal and state fisheries field staff and local partners actively assisting in monitoring fish. Over 80 field biologists contributed information about how, when, where, and who collects, processes, and interprets VSP and related hatchery information. The assessment provided an inventory of ongoing VSP, and related hatchery effectiveness monitoring; an evaluation of data quality and certainty; and data improvement actions needed to fill high priority gaps. The analysis was scored based on how well the information approached the recommended monitoring standards in the NOAA Guidance. The maximum possible score was 120.

Scores for Chinook salmon were good to fair. The few exceptions were Nooksack, and White, Rivers where there are problems counting adult spawners due to environmental conditions or in trapping juvenile migrants. In all of the TRT populations surveyed in Puget Sound where spawner abundance estimates are based on redds no estimates of precision were available. Therefore, there are no confidence limits around these data to indicate how much trust should be placed on the estimated run sizes. A few areas are trying different approaches such as the Elwha where a floating weir is employed in conjunction with a DIDSON sonar counter to try to calibrate estimates of adult Chinook passing the location near the mouth. Precision estimates have been made at this site in the past two years (CV<17%). Genetic mark-recapture projects that use DNA analysis of both juveniles and adults for determining adult abundance are being implemented in the Green, Snohomish and Stillaguamish basins. If successful it will determine not only adult abundance but also other VSP information such as genetic diversity, sub-populations within a watershed, spatial distribution of specific adults and their offspring and marine survival. Some hatchery programs supplementing or using natural origin spawners for their program have the potential for obscuring natural production measures and should be carefully monitored so that all hatchery origin fish can be identified both as juveniles and adults either through determining the proportion of hatchery origin spawners or through DNA sampling.

Steelhead population monitoring is dramatically deficient with all but five populations having an overall score of 40 or less points out of 120 possible points. An exception is Snow Creek in Discovery Bay where a steelhead weir has been present since 1977 to count adults and juveniles and to obtain other life history information. The other exceptions are Skagit, Green, Puyallup, and White which have only a modest score of 40-60. The co-managers overall were unable to determine overall adult steelhead abundance with any degree of accuracy. Only two populations were given a perfect score for adult

abundance monitoring (Green River, and Snow Creek) and this was provided based upon tentative information. There are five identified summer steelhead populations in Puget Sound: South Fork Nooksack, Deer Creek, Canyon Creek, Tolt, and North Fork Skykomish. Two of the summer steelhead populations have estimates of adult abundance; little can be said of the status or trends of the others. Twenty steelhead populations lack estimates of juvenile migrants so no freshwater productivity estimates can be made for those populations. Since 2006, the hatchery program production in Puget Sound has been reduced by 50 percent. Migrating steelhead are seldom caught while sampling for salmon juveniles who follow the shorelines in Puget Sound. Preliminary acoustic studies suggest that substantial mortality may be occurring in Puget Sound prior to reaching the Pacific Ocean.

Table 1. Total cost of filling priority gaps for Puget Sound ESA listed salmon and steelhead

ESA Listed Species	Ongoing Costs	New Annual Costs	New One Time Costs	TOTAL Costs
Puget Sound Chinook ESU				
Hood Canal MPG	$687,266	$90,000	$335,000	$1,112,266
Juan de Fuca MPG	$816,430	$779,000	$255,000	$1,850,430
Georgia Strait MPG	$555,500	$216,000	$324,880	$1,096,380
North Sound MPG	$3,460,373	$1,722,734	$509,880	$5,692,987
Central-South Sound MPG	$1,197,536	$2,066,731	$1,271,500[1]	$4,535,767
Sub-total	**$6,717,105**	**$4,874,465**	**$2,696,260**	**$14,287,830**
Summer Chum ESU				
Hood Canal-Straits	**$168,000**	**$140,100**	**$0**	**$308,100**
Puget Sound Steelhead DPS				
Olympic MPG	$300,593	$451,260	$676,200	$ 1,428,053
North Cascade MPG	$506,939	$463,000	$334,500	$1,304,439
Central-South Sound MPG	$505,000	$645,000	$185,000	$1,335,000
All Puget Sound	$0	$141,200	$220,525	$361,725
Sub-total	**$1,312,532**	**$1,700,460**	**$1,416,225**	**$4,429,217**
TOTAL	**$ 8,197,637**	**$6,715,025**	**$4,112,485**	**$19,025,147**

Puget Sound summer chum are being monitored well considering the number of small populations involved in the Hood Canal and Discovery Bay. Greatest risk to monitoring is reduction of funding which relies upon short term grants.

All VSP gaps were prioritized as Highest, High, or Lower by the co-managers. A proposal with estimates of costs was developed by the co-managers for most identified gaps and the totals are shown in Table 1 for Chinook, summer chum, and steelhead. Most ongoing funded costs were identified and any that were considered at high risk of funding failure were also shown in the columns for "New Annual Operating Costs" and/or "New One Time Costs". This was especially true for PCSRF Hatchery Reform money earmarked by Congress in the past but no longer available. As a result total costs are somewhat over stated due to appearing twice in the table both under Ongoing Costs and New Costs. A table has been included in the report that describes hatchery reform operational and facility needs left unfunded.

[1] Does not include approximately 100 million dollars needed by the Corps of Engineers to reconstruct fish passage facilities at the Buckley Dam and the Hiram Chittenden Locks where mortality occurs on ESA listed Chinook and steelhead

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WORK GROUP PARTICIPANTS

Thanks to the following field biologists and managers who contributed to the information provided in this report and to the completed detailed VSP tables and summary sheets and proposed improvements. They are the backbone of salmon and steelhead monitoring and do an excellent job considering the limited funding, staff and time at their disposal.

Name	Organization	Sub-region
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Name	Organization	Sub-region
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INTRODUCTION

The Puget Sound Partnership (PSP) is charged with recovering the Puget Sound Ecosystem by 2020 and is also the state agency responsible for implementing the regional Chinook salmon recovery plan approved by the National Marine Fisheries Service. It is also designated as the regional salmon recovery organization for Puget Sound salmon species and is responsible for developing recovery plans for salmon, orca, and other species in Puget Sound that are listed under the federal endangered species act with the exception of summer chum salmon which are the responsibility of the Hood Canal Coordinating Council.

The Partnership is leading the effort to develop and implement the Puget Sound Ecosystem Monitoring Program. As the Partnership does not perform data collection, the Program is designed to leverage existing monitoring programs to support data collection and management, analysis, and reporting. Furthermore, the Program functions to identify gaps in monitoring and propose new monitoring studies to address the gaps. The Program is structured to engage a broad range of stakeholders and partners via a Steering Committee, and a series of topical Work Groups, each having specific roles and relationships to each other, and collectively working towards strategizing monitoring efforts, improving coordination, and ensuring that policy and management-relevant data are shared and available for the Partnership's performance management system.

The National Marine Fisheries Service has just completed a five year review of salmon and steelhead listed under the federal Endangered Species Act (Ford 2011). Those findings were based upon existing monitoring programs conducted by the Washington Department of Fish and Wildlife and the Puget Sound treaty tribes.

The Puget Sound Federal Caucus in 2010 approved the use of funds to conduct an assessment of the ongoing monitoring of viable salmonid population (VSP) monitoring to determine the quality of listed salmon and steelhead population abundance, productivity, distribution, and diversity estimates and protocols (McElhany, et al. 2000). This was considered necessary in order to meet the needs of the Puget Sound Partnership dashboard indicators and to improve data collection and data reporting. Funding was provided through an interagency agreement between the U.S. Environmental Protection Agency and the National Marine Fisheries Service.

Objectives of the study were to:

1. Determine the methods, precision, accuracy, and frequency of data collected by the co-managers and others participating partners for VPS status/trends, hatchery effectiveness monitoring, and Key Ecological Attributes for the summer chum and Chinook evolutionarily significant units (ESUs) and the steelhead distinct population segments (DPS) in Puget Sound.
2. Based on Objective 1 develop a prioritized list of needed improvements to monitoring that address precision, accuracy, and other gaps or uncertainties
3. Based on Objective 2 develop funding proposals to address major regional priorities.

4. To the extent possible crosswalk the assessment with the Key Ecological Attributes identified by the RITT and through the Open Standards process adopted by the PSP.
5. Develop a map of the steps for developing and reporting the data for the dashboard indicators for Chinook wild abundance, commercial harvest, and sport catch license sales.

This report is intended to address the viability components of monitoring as illustrated in the box to the left in the NMFS Listing Status Decision Framework (Figure 1). A later report will address the status of monitoring of Statutory Listing Factor 1: The present or threatened destruction , modification, or curtailment of its habitat or range.

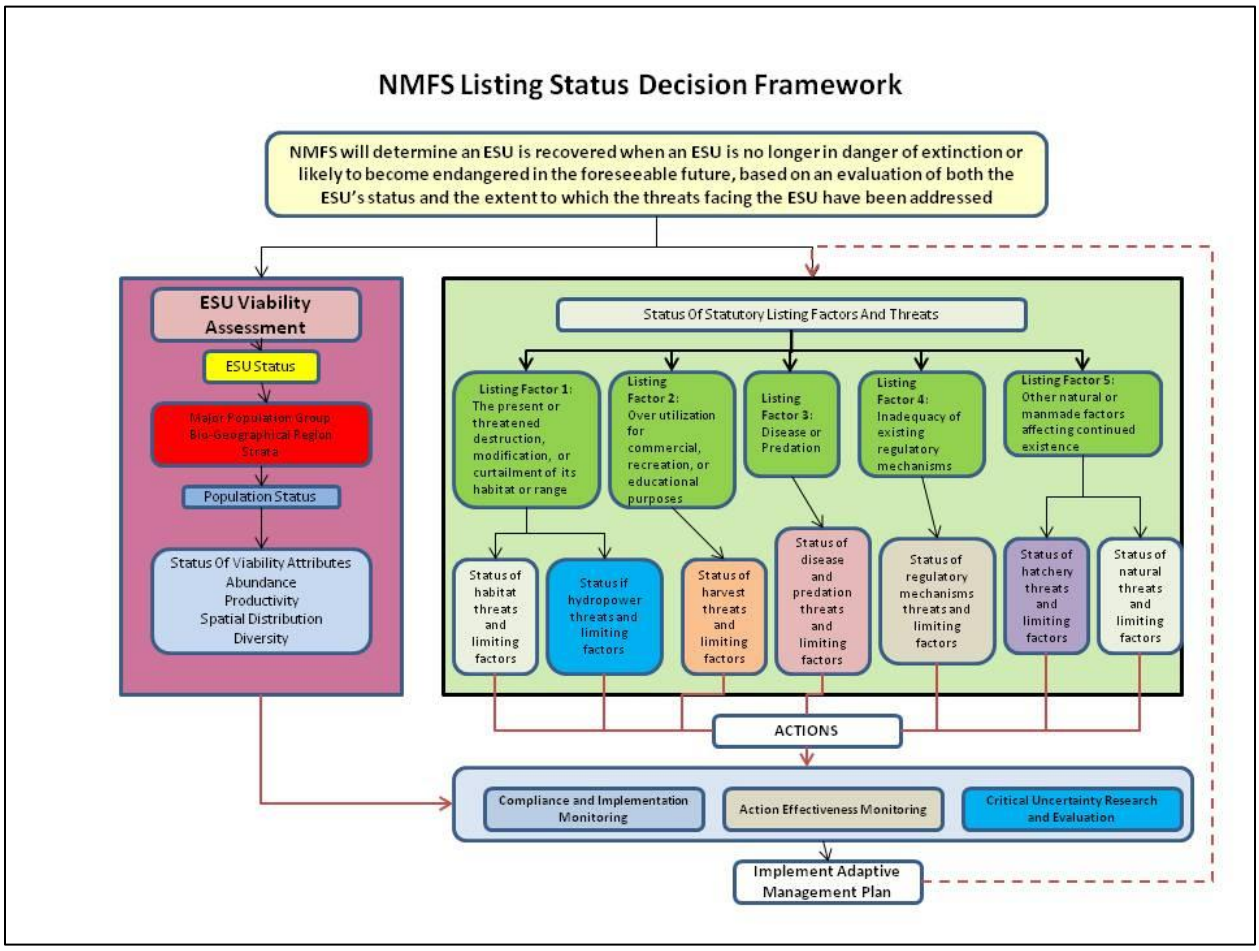


Figure 1. National Marine Fisheries Service Listing Status Decision Framework

METHODS

A series of 15 sub-regional meetings were held with the field staff of the tribal and state fisheries offices as well as other local government participants and non-profit organizations assisting in monitoring fish from January through November 2011. The sub-regional meetings included: Hood Canal, Strait of Juan de Fuca, Nooksack-Samish Watersheds, Skagit Watershed, Stillaguamish-Snohomish Watersheds, Lake Washington-Green-Puyallup Watersheds, and Nisqually-South Sound Watersheds. Over 80 field biologists contributed information about how, when, where, and who collects, processes, and interprets VSP and related hatchery information as part of the PSEMP Salmonid Work Group.

VSP Regional Survey

A series of questions were developed to discuss with the field staffs to address VSP characteristics which were derived in cooperation with the Puget Sound Recovery Implementation Technical Team (RITT) to make it consistent with the "Open Standards For The Practice Of Conservation" process adopted by the PSP. The assessment provided an inventory of ongoing VSP, and hatchery monitoring related to VSP evaluations; an evaluation of data quality and certainty; and data improvement actions needed to fill high priority gaps. NOAA's *"Guidance for Monitoring Recovery of Salmon and Steelhead"* (Crawford and Rumsey 2011) and the Washington Forum on Monitoring adopted protocols were used as a standard with which to compare ongoing actions. This was accomplished for each ESA listed TRT population in each MPG of each ESU and DPS in Puget Sound and Hood Canal.

Adult Abundance

The following questions were asked about how the co-managers calculated adult abundance estimates for each population.

1. What is the method used to determine number of spawners, redds?
2. What is the frequency of sampling?
3. Is it a full estimate of entire population?
4. Who calculates the spawner abundance?
5. What is the formula?
6. Where are the data stored?
7. How are numbers of adult recruits prior to fishing calculated?
8. Is egg deposition calculated?
9. Is intra-gravel mortality calculated? If so how?
10. Are hatchery fish externally marked or internally marked?
11. Is fecundity measured?
12. Is there a calculated precision in terms of confidence limit (CI) or coefficient of variation (CV) value? If so what is it?
13. Is there an annual estimate of observer efficiency?
14. Is there an estimate of the average time an individual salmon/steelhead remains in the survey area? How often is it estimated?

Based on the answers to the above questions an evaluation was made about how well the procedure fit the scoring categories listed in table 2 which were derived from the *"Guidance for Monitoring Recovery of Salmon and Steelhead"*.

The answers to the above questions enabled an evaluated score based on the following values given. A high score of 45 was possible.

Table 2. Scoring table for population adult abundance estimates.

VSP & KEA	Score	Scoring Criteria
Method used to determine number of spawners	10	• Full census or full unbiased estimate of entire population throughout the spawning time period. • Abundance measurements meet CV guidelines
	8	• Abundance meets CV guidelines, • Unbiased estimate, • Full estimate of tributary population or part of main stem as an index
	6	• Abundance estimate does not meet CV guidelines, • Unbiased estimate, • Full estimate of entire population throughout the spawning time period
	4	• Biased annual index sites coupled with periodic broad full watershed census of redds or fish
	2	• Biased index sites sampled periodically for redds or fish
	0	• No estimates
Method for determining egg deposition	5	• Estimated from annual studies of redd deposition using pumps or traps and female egg retention studies
	3	• Estimated from previous research studies
	0	• No estimate
Egg to Swim-up fry survival	5	• Measured using fry traps, egg pumps, etc. periodically
	3	• Estimated from juvenile parr densities and known redd counts
	0	• Not estimated
Recruits prior to harvest or other man caused mortality	5	• Estimated from harvest numbers plus dam mortality plus other human mortality factors if known
	4	• Estimated from harvest estimates only all other mortality considered natural marine mortality
	3	• Harvest measured using surrogate hatchery mortality estimates for nearby hatchery stocks
	0	• Harvest mortality not measured
Hatchery Fish are marked	5	• External clip and also CWT or PIT tag applied to all released fish
	3	• Internal mark only (CWT, otolith, PIT tag) applied to all released fish
	2	• Marks applied to some of the released fish but not all.
	0	• No external or internal mark applied to released fish
PHOS is measured?	10	• PHOS estimates are based upon sample of entire population,
	8	• PHOS based upon a tributary sample or upper watershed weir,
	6	• PHOS estimates based upon intermittent biased sampling or hatchery rack counts
	4	• PHOS not accurate due to unmarked hatchery fish
	0	• No PHOS measurement conducted
Method for determining fecundity	5	• Measured at least every five years
	3	• Measured previously by special study
	0	• Not measured

Productivity

The following questions were asked about how the co-managers calculated productivity estimates for each population.

1. How are sex ratios and age composition determined in spawners?
2. Is hatchery - wild proportion (PHOS-PNOS) measured on spawning grounds? If so how? Are there unmarked hatchery fish released into this watershed?
3. How are cohorts determined and calculated? Who does this?
4. How is harvest of natural origin proportion determined?
5. Is there a calculated confidence interval (CI) or coefficient of variation (CV) value for harvest?
6. How is natural marine survival determined?

The answers to the above questions enabled an evaluated score based on the following values given. A high score of 35 was possible.

Table 3. Scoring table for population adult productivity estimates.

VSP & KEA	Score	Scoring Criteria
Sex ratios and age structure is measured?	10	• Sex ratio and age structure determined annually at a main stem weir or other sampling location
	8	• Sex ratio and age structure determined annually at a tributary weir or other index sampling location.
	6	• Sex ratio and age structure extrapolated from nearby watershed or one time measurement in the past.
	4	• Sex ratio and age structure extrapolated from nearby hatchery stock or one time measurement in the past.
	0	• Adult productivity estimate not possible
Cohort reconstruction is conducted?	10	• Cohort reconstructions routinely done
	5	• Cohort reconstruction periodic
	0	• Cohort reconstruction not done
Harvest estimates are reliable?	10	• Estimates of harvest upon natural stock is reliable based on natural CWT, PIT tags or genotyping of wild populations
	5	• Harvest estimates based on hatchery surrogates. Or delegated based on timing of the run for chum and based on percentage returns
	0	• No harvest estimate
Marine survival estimated?	5	• Determined by dividing number of adults natural spawners by the estimated number of natural juvenile migrants'
	3	• Estimated using hatchery released juveniles and hatchery rack returns at a nearby hatchery as a surrogate for wild-natural fish.
	0	• Not estimated

Juvenile Abundance

The following questions were asked about how the co-managers calculated juvenile abundance estimates for each population.

1. Are juvenile migrants trapped for this population? If so where is the trap located? What is the trapping duration? Is there a calculated CI or CV value for this trap?

2. Are freshwater fry or parr densities calculated? How? When?
3. Are fry and parr densities calculated for marine nearshore areas?
4. Are juveniles being CWT or PIT tagged? If so how is the information used?
5. Are emergent fry estimated or measured? What method is used?
6. Is the accuracy and precision of the migrant trapping determined (confidence)? If so how often?
7. Are juveniles being CWT or PIT tagged? If so how is the information used?
8. Are emergent fry estimated or measured? What method is used?

The answers to the above questions enabled an evaluated score based on the following values given.

The answers to the above questions enabled an evaluated score based on the following values given. A high score of 20 was possible.

Table 4. Scoring table for population juvenile abundance estimates

VSP & KEA	Score	Scoring Criteria
How is Juvenile Migrant Abundance estimated?	5	• Juvenile Abundance meets CV precision guidelines, • Unbiased estimate, • Full estimate of entire migration period from TRT population
	4	• Juvenile abundance meets CV guidelines, • Unbiased estimate, • Full estimate of tributary population or part of main stem as an index
	3	• Abundance estimate does not meet CV guidelines, Unbiased estimate, and full estimate of entire population over entire migration period.
	2	• Abundance estimate does not meets CV guidelines, Unbiased estimate, Full estimate of a tributary population as an index
	1	• Abundance estimate does not meet CV guidelines, Biased estimate, and Partial estimate of a migration period.
	0	• No juvenile migrant trapping
Are juvenile freshwater parr or fry densities measured?	5	• Densities (#/m2) measured at index sites and extrapolated to the population
	2	• Relative abundance index compared with other species
	0	• Not measured
Are juvenile nearshore marine parr or fry densities measured?	5	• Densities measured at tow net sites, beach seines, or by using other quantitative methods and extrapolated
	0	• None
Are juvenile offshore juvenile densities measured?	5	• Densities measured at mid-water trawl sites, hydroacoustics, or by using other quantitative methods and extrapolated
	0	• None

Spatial Distribution

The following questions were asked about how the co-managers calculated spatial distribution estimates for each population.

1. How is freshwater spatial distribution determined for the population?
2. How is Puget Sound nearshore distribution determined for juveniles? For ocean migration?
3. How is freshwater migration timing and spawn timing determined?
4. How is estuary timing determined?
5. Is the accuracy and precision of the distribution determined (confidence)? If so how often?

The answers to the above questions enabled an evaluated score based on the following values given. . A high score of 10 was possible.

Table 5. Scoring table for population spatial distribution estimates.

VSP & KEA	Score	Scoring Criteria
FW Spatial Distribution?	5	• Randomized ground surveys of juvenile parr abundance and distribution within the population
	4	• Complete census or randomized aerial or ground counts of total distribution of spawners within the population
	3	• Random survey sites within portions of the population
	2	• Non-random index site parr density estimates or non-random index site density and distribution estimated for adult spawners, or • Modeling based on geomorphic features
	1	• Use of radio tags or PIT tags to determine spatial distribution
	0	• No adult or juvenile distribution estimates
Marine Nearshore Spatial Distribution?	5	• Distribution tracked with probabilistic sampling design
	3	• Non-random tows or sampling, with biased sampling design
	1	• shore visual surveys, etc. no sampling design
	0	• Distribution not tracked

Diversity

The following questions were asked about how the co-managers evaluated species diversity for each population.

1. How is species diversity such as run timing, spawn timing, size, and behavior, tracked?
2. Is genetic diversity being tracked through DNA sampling? If so how often?

The answers to the above questions enabled an evaluated score based on the following values given. . A high score of 10 was possible.

Table 6. Scoring table for population diversity estimates.

VSP & KEA	Score	Scoring Criteria
Diversity Phenotypes	5	• Evaluation of changes in run timing, sex ratios, age structure, size at maturity are evaluated periodically from high proportion of the run
	3	• Changes in diversity measures evaluated from some data periodically from tributary sources or carcass index sites.
	1	• Evaluation of changes in diversity rely upon data taken from sport fishery or occasional spot samples
	0	• No diversity evaluations exist and little or no data exists
Genetic Diversity	5	• Representative DNA samples collected on an ongoing basis from a high proportion of the population distribution.
	3	• DNA samples taken from a tributary weir or site not necessarily representative of the entire population
	1	• Some DNA collected on a spot basis from fishery or other survey
	0	• No samples taken

The total possible score from all of the above VSP scoring tables is 120. The following table displays the maximum number of points that could be obtained based on the monitoring guidance and the relative importance of each VSP characteristic to determining salmon recovery.

Table 7. Total possible score for each VSP evaluation criterion.

Viable Salmonid Population Criterion	Highest Possible Score
Adult Abundance	45
Productivity	35
Juvenile abundance	20
Spatial Distribution	10
Diversity	10
Grand Total	**120**

Hatchery Effectiveness Monitoring

1. Are you supplementing any wild populations with hatchery fish? If so where?
2. Do you have a strong experimental design? BACI, BA, other designs.
3. Is there an evaluation time frame established or end point for the supplementation program?
4. Are there any reproductive fitness studies underway or recently completed for this major population group (MPG) or population?

These four hatchery related questions were included in the scores for diversity.

A series of 16 VSP tables were completed which detailed the field methods used, parameters measured, and methods of calculation for adult spawner abundance, adult life history and productivity information, juvenile migrant and other juvenile information, marine survival and distribution information, and overall physical and genetic diversity based on the questions above. Those tables are posted on the Puget Sound Partnership world wide website at http://mypugetsound.net.

Data Quality Objectives

Data quality objectives were based on the stated objectives of the program. Objectives for precision, bias, representativeness, completeness and comparability are described below. All aspects of the assessment were designed to determine the status of ongoing monitoring as it relates to these objectives and the NOAA "*Guidance for Monitoring Recovery of Pacific Northwest Salmon and Steelhead listed under the Federal Endangered Species Act"* (Crawford and Rumsey 2011).

Precision

The *"NOAA Guidance"* recommends that all adult and juvenile migrant abundance estimates of salmon and steelhead meet the following precision guidelines:

- Incorporate a robust unbiased adult spawner abundance sampling design that has known precision and accuracy.
- Agencies and tribes, as a first step to improved data quality, should calculate the average coefficient of variation for all adult natural origin spawner databases for ESA populations and provide that information to all interested parties.
- Agencies and tribes should strive to have adult spawner data with a c*oefficient of variation* (CV) on average of 15% or less for all ESA populations.
- Agencies and tribes should conduct a power analysis for each natural population monitored within an ESU to determine the power of the data to detect a significant change in abundance and to provide that information to all interested parties.
- Agencies and tribes should obtain estimates of juvenile migrants for at least one significant population for each MPG within an ESU or DPS.
    a. The goal for all populations monitored for juvenile migrant is to have salmon data with a CV on average of 15% or less and steelhead data with a CV on average of 30% or less.
    b. A power analysis for each juvenile migrant population being monitored within an ESU should be conducted to determine the power of the data to detect a significant change in abundance and to provide that information to all interested parties.
- Estimates of spatial distribution of listed Chinook, coho, and steelhead should have the ability to detect a change in distribution of ± 15% with 80% certainty.

Bias and Known Sources of Error

In order to avoid or reduce bias and sources of error the *"NOAA Guidance"* recommends that the states and tribes:

- Incorporate a robust unbiased adult spawner abundance sampling design.

- Monitor ratio of marked hatchery salmon and steelhead to unmarked natural origin fish in all adult spawner surveys
- Manage exploitation rates and total catch in coast wide fisheries and terminal fisheries for technical review team (TRT) identified natural populations phasing out the use of all hatchery-natural stock aggregates.
- The states and tribes should be able to demonstrate that there was a greater than 90% compliance with adopted fishery regulations designed to minimize incidental take of listed species.
- Monitor delayed mortality of released and drop out listed species in all harvest and catch and release fisheries at least every five years.

Representativeness

All ESA listed populations within each Puget Sound ESU and DPS were evaluated for their monitoring, the results represent the condition of monitoring within those populations, MPGs, and ESU/DPS as of 2011.

Completeness

Useable data about the current status of monitoring was obtained from 100% of the identified summer chum, Chinook, and steelhead populations within the Puget Sound. Every population had an opportunity to be evaluated in the process. Gap analysis and potential funding scenarios were derived from collaborative discussions between the co-manager field staff at face to face meetings.

Comparability

The same process was completed in the Columbia basin in 2009 and can be compared to these results when completed because both processes use the *"NOAA Guidance"* as a measure of compliance and data quality.

Quality Control Procedures

All data collected by the participants and summarized by the author was provided to the participants for editing and corrections to be sure that the content in the tables and summary are accurate and state the conditions of monitoring and the shortcomings without bias by the author.

After completing the VSP analysis, the information was scored based on how well the information approached the recommended monitoring standards in the NOAA Guidance. A maximum possible score of 120 was derived based on monitoring methods, precision, and overall quality. The scores were used to develop a Summary table for each major population group (MPG) that provides a quick comparison of the quality of the monitoring for each TRT population within the MPG by species. In attempting to address monitoring for all of the key ecological attributes identified (KEA) by the RITT, some monitoring questions were asked that in general practice are seldom monitored and data is seldom collected. This is due either to the inherent difficulties of collection or that the factor can be included or calculated

from other monitoring measures. In general, almost all populations received a zero score for questions regarding estimating egg deposition and egg to fry survival. Also, very few populations had monitoring addressing fecundity measures for wild fish, but depended upon hatchery surrogates or old data collected in the past. Other KEA measures seldom collected include juvenile densities in freshwater, marine offshore, and in the nearshore area. These, almost universal gaps, tended to reduce the overall scores of all populations and explains why no population received a score over 94.

OPEN STANDARDS PROCESS

The Nature Conservancy's "Open Standards For The Practice Of Conservation" process was adopted by the Puget Sound Partnership as its formal approach to identifying the various aspects of ecosystem adaptive management and monitoring. The process requires a strict structured approach to describing and defining the ecosystem being modeled. It requires the development of target ecosystems or portions of ecosystems of interest. In the case of Puget Sound Chinook salmon, it includes other species and food webs, freshwater habitat and marine nearshore habitat. This process also calls for identifying stresses that affect the conservation targets. A stress is an impaired aspect of a conservation target that results directly or indirectly from human activity. This allows for creation of a conceptual model as to how the ecosystem functions and the stresses upon it. Additional things can be added such as strategies to overcome the threats, contributing factors, and drivers. Part of the process is to develop key ecological attributes (KEAs). Key ecological attributes are the characteristics of an ecosystem component that, if present, would support species viability but, if missing or altered, would lead to loss or degradation of the component over time. In the case of Chinook the processes that demonstrate the various life history components of salmon include but are not limited to egg deposition, emergent fry, spawning adults, and the stream habitat components that affect them.

The Puget Sound Recovery Implementation Technical Team has been using this process for Puget Sound and has identified the KEAs for Chinook. This VSP assessment was coordinated with the RITT to be sure to cover their analyses. The following diagram (Figure 2. KEA life history stages for Chinook.) is taken from the RITT Template. The RITT Template does not address chum or steelhead. The Chinook KEA template was also applied to those species since no other was already available. As might be expected, not all aspects of the life history of Chinook, steelhead, or chum are measured routinely. The reasons for not measuring, for example, egg to emergent fry survival are (1) it is difficult to trap a viable redd and determine the number of eggs deposited and the number that ultimately hatch and swim up as emergent fry; (2) the information is of secondary importance in determining the overall status/trends of the population; and (3) it could be restricted as a "taking" under the ESA.. Therefore, Figures 2-4 show no monitoring for this KEA for nearly all populations. They are shaded red in the tables but their measurement is not crucial. On the other hand, if adult abundance is not measured, this is a crucial gap and those populations with inadequate monitoring should be addressed. KEAs with moderate monitoring and room for improvements are shown in yellow.

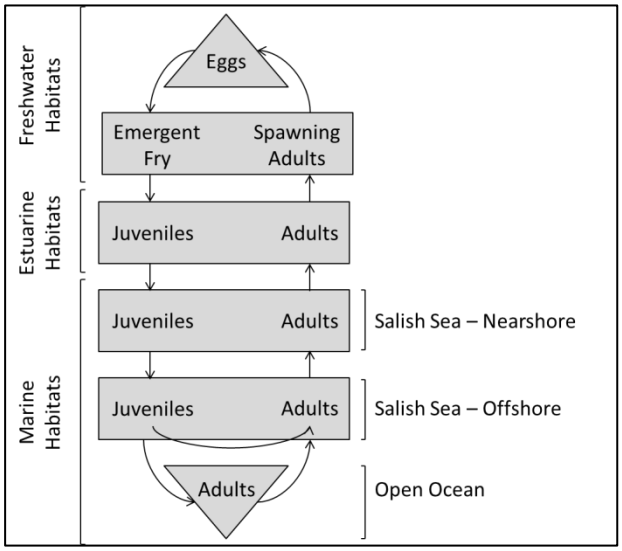


Figure 2. KEA life history stages for Chinook. (Extracted from the RITT Framework template.)

TRT Population	Adult spawner Abundance measured?	Ave Egg deposition determined?	Egg to fry survival calculated?	Recruits Prior to Fishing estimated?	Hatchery Fish are marked?	PHOS Measured?	Fecundity Measured?	ex ratios and age determined?	uvenile migrant Abundance & Productivity SAR?	Cohort reconstruction?	Harvest Estimates are reliable?	Marine survival measured?	uvenile FW parr or fry densities measured?	Juvenile marine nearshore densities measured?	Offshore densities are measured?	FW Spatial Distribution?	Marine nearshore spatial distribution?	Species Diversity Age, run timing, cohort structure,	Species Diversity DNA and genetic diversity	Score
Mid Hood Canal Chinook	6	0	0	5	3	10	5	10	5	10	5	5	0	0	0	5	0	5	5	79
Skokomish Fall Chinook	6	0	0	5	3	10	0	10	5	10	5	5	0	0	0	5	0	5	5	74
Dungeness River Chinook	6	0	0	3	3	10	5	10	5	10	7	3	0	0	0	4	3	5	5	79
Elwha River Chinook	6	0	0	3	3	10	3	10	5	10	5	3	0	0	0	3	0	5	5	71
NF Nooksack	2	2	0	4	4	10	3	8	3	10	7	3	0	0	0	3	0	3	5	67
SF Nooksack	5	0	0	3	4	10	3	0	3	0	7	0	0	0	0	4	1	3	5	48
Lower Skagit Fall Chinook	5	3	0	4	5	10	5	9	5	10	9	5	0	5	0	3	5	5	5	93
Upper Skagit Summer Chinook	5	3	0	4	5	10	5	9	5	10	9	5	0	5	0	3	5	5	5	93
Upper Cascade Spring Chinook	10	3	0	4	5	10	5	9	5	10	9	5	0	5	0	3	5	5	1	94
Lower Sauk Summer Chinook	5	2	0	4	5	0	2	9	5	10	9	5	0	5	0	3	5	5	4	78
Upper Sauk Spring Chinook	10	2	0	4	5	0	2	9	5	10	9	5	0	5	0	3	5	5	4	83
Suiattle Spring Chinook	10	2	0	4	5	0	2	9	5	10	9	5	0	5	0	3	5	5	4	83
NF Stillaguamish	5	3	0	4	4	10	5	10	3	10	7	0	2	3	0	4	0	5	5	80
SF Stillaguamish	5	3	0	4	5	10	5	10	3	10	7	0	0	3	0	4	0	5	5	79
Skykomish	5	0	0	4	5	10	2	10	3	10	7	4	0	2	0	4	3	5	3	77
Snoqualmie	6	0	0	4	5	10	0	10	3	10	7	4	0	2	0	4	3	5	3	76
Sammamish	8	0	0	3	4	6	2	10	5	0	5	3	0	0	0	4	2	5	5	62
Cedar	10	0	0	3	4	10	2	10	5	10	5	4	3	0	0	4	2	5	5	82
Green/Duwamish	10	0	0	3	4	10	2	10	5	10	5	3	2	3	0	4	3	5	5	84
Puyallup	4	0	0	4	5	10	2	10	5	10	5	3	0	0	0	4	3	3	2	70
White	5	0	0	5	3	8	2	10	0	8	5	3	0	0	0	3	3	3	3	61
Nisqually	8	0	0	3	5	10	3	10	5	10	5	5	0	5	0	3	3	3	5	75

Figure 3. KEA scores for Puget Sound Chinook where the dark color red identifies low monitoring scores, speckled yellow identifies moderate monitoring, and green (lighter shading) represents adequate monitoring.

TRT Steelhead Population	Adult Spawner Abundance	Ave Egg deposition is determined	Egg to fry survival is calculated	Recruits Prior to Fishing is estimated	Hatchery Fish are marked	PHOS is Measured	Fecundity is Measured	Sex ratios and age is determined annually	Juvenile Migrant Abundance determined	Cohorts reconstructed annually	Harvest Estimates are reliable	Marine survival is measured annually	Juvenile FW parr or fry densities measured?	Juvenile nearshore densities are measured	Offshore densities are measured periodically	FW Spatial Distribution is known	Marine nearshore spatial distribution is mapped	Species Diversity life history is tracked	Species Genetic Diversity measured	Score
Drayton Harbor WSH	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	2	0	0	0	7
Nooksack WSW	8	0	0	0	5	0	0	0	0	0	0	0	0	0	1	4	0	1	1	20
SF Nooksack SSH	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6
Samish WSH	4	0	0	0	5	0	0	0	0	0	8	0	1	0	0	2	0	1	5	26
Skagit WSH/SSH	4	0	0	3	5	0	0	4	1	5	3	3	1	2	0	3	3	3	5	45
Nookachamps Cr WSH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baker WSH/SSH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sauk SSH/WSH	4	0	0	3	5	0	0	4	1	5	3	3	1	2	0	3	3	3	5	45
Stillaguamish Deer Cr SSH	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	2	0	0	0	7
Stillaguamish WSH	6	0	0	0	5	0	0	0	1	0	0	0	0	0	1	4	0	1	1	19
Stillaguamish Canyon Cr SSH	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6
Snohomish/ Skykomish WSH	4	0	0	0	5	0	0	0	0	0	8	0	1	0	0	2	0	1	5	26
Pilchuck WSH	4	0	0	0	5	0	0	0	0	0	8	0	1	0	0	2	0	1	5	26
Snoqualmie WSH	4	0	0	0	5	0	0	0	0	0	8	0	1	0	0	2	0	1	5	26
NF Skykomish SSH	4	0	0	0	5	0	0	0	0	0	8	0	1	0	0	2	0	1	5	26
Tolt SSH	8	0	0	0	5	0	0	0	0	0	8	0	1	0	0	2	0	1	5	30
N Lk Washington Sammamish WSH	0	0	0	0	5	0	0	0	2	0	0	0	3	0	0	0	0	2	2	14
Cedar WSH	4	0	0	0	5	0	0	0	2	0	0	0	3	0	0	3	0	3	2	22
Green WSH	10	0	0	0	5	0	5	8	5	5	8	0	0	0	0	4	3	3	5	61
Puyallup-Carbon WSH	8	0	0	3	5	6	0	0	5	5	8	0	1	3	0	4	3	3	5	59
White WSH	5	0	0	3	5	0	3	4	0	5	8	0	0	0	0	4	0	3	5	45
Nisqually WSH	4	0	0	3	4	0	0	0	5	0	5	0	0	0	0	3	2	1	1	28
South Sound WSH	2	0	0	0	4	0	0	0	2	0	8	0	3	0	0	2	1	0	0	22
East Kitsap WSH	2	0	0	0	4	0	0	0	4	0	8	0	0	3	0	2	3	0	0	26
Olympic W. Hood Canal WSH	2	0	0	3	5	0	0	0	4	0	5	0	0	0	0	2	5	3	5	34
Skokomish WSH	3	0	0	3	0	0	0	0	2	0	0	2	0	0	0	2	0	3	5	20
E. Hood Canal WSH	3	0	0	3	0	0	0	0	4	0	0	0	0	0	0	2	0	3	5	20
S. Hood Canal WSH	3	0	0	3	0	0	0	0	3	0	0	0	0	0	0	2	0	2	5	18
Juan de Fuca Lowland Tributaries WSH	6	2	2	2	2	2	2	5	4	3	8	3	2	0	0	3	0	5	3	54
Dungeness WSH	2	0	0	0	4	0	2	0	3	0	0	0	0	0	0	2	0	3	1	17
Elwha WSH	6	0	0	3	5	0	0	4	1	0	5	0	0	0	0	2	0	5	5	36
Straits Independent WSH	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	2	0	10

Figure 4. Steelhead KEA scores by TRT population where the dark color red identifies low monitoring scores, speckled yellow identifies moderate monitoring, and green (lighter shading) represents adequate monitoring

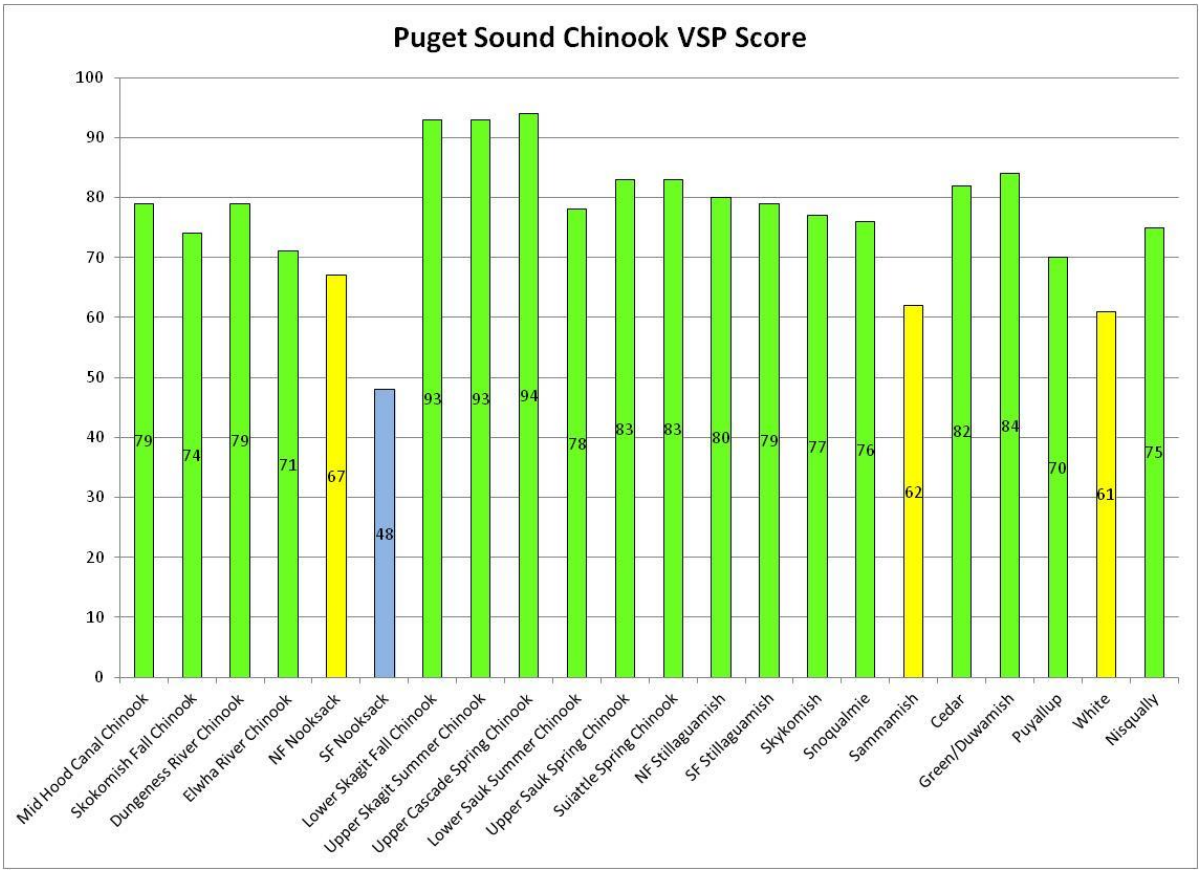
TRT Population	Adult Spawner Abundance	Ave Egg deposition is determined	Egg to fry survival is calculated	Recruits Prior to Fishing is estimated	Hatchery Fish are marked	PHOS is Measured	Fecundity is Measured	Sex ratios and age is determined annually	Juvenile Migrant Abundance determined	Cohorts reconstructed annually	Harvest Estimates are reliable	Marine survival is measured annually	Juvenile FW parr or fry densities measured?	uvenile nearshore densities are measured	FW Spatial Distribution is known	Marine nearshore spatial distribution is mapped	Species Diversity life history is tracked	Species Genetic Diversity measured	Score
Union River	10	0	0	5	3	5	5	10	0	10	5	3	0	3	5	0	5	5	74
Lilliwaup	6	0	0	3	3	10	3	8	0	10	5	3	0	0	5	0	5	5	66
Hamma Hamma	6	0	0	3	3	10	3	10	5	10	5	5	0	0	5	0	5	5	75
Duckabush	6	0	0	3	3	10	0	10	5	10	5	5	0	0	5	0	5	5	72
Doswallips	6	0	0	3	3	10	0	10	0	10	5	3	0	0	5	0	5	5	65
Big & Little Quilcene	4	0	0	3	3	10	3	10	0	10	5	0	0	0	5	0	5	3	61
Dewatto	6	0	0	3	3	10	0	10	0	10	5	5	0	0	5	0	5	3	65
Tahuya	6	0	0	3	3	10	0	10	0	10	5	5	0	0	4	0	5	3	64
Anderson	6	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	3	3	18
Big Beef	8	0	0	3	3	10	3	10	0	10	5	5	0	0	2	0	5	5	69
Skokomish	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	0	7
Finch	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Chimacum Creek	6	0	0	5	3	10	3	10	0	10	5	3	0	0	3	0	5	5	68
Snow Creek Salmon Creek	8	0	3	5	3	10	5	10	5	10	5	5	0	0	4	0	5	5	83
Jimmycomelately Creek	10	0	0	5	3	10	5	10	0	10	5	3	0	0	5	0	5	5	76
Dungeness River	6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	8

Figure 5. KEA scores for Puget Sound summer chum where the dark color red identifies low monitoring scores, speckled yellow identifies moderate monitoring, and green (lighter shading) represents adequate monitoring

CHINOOK SALMON VSP ASSESSMENT

The scores for Chinook salmon were on average good to fair as shown in the following figure for each TRT population. The few exceptions were Nooksack, White, and Sammamish Rivers where there are problems counting adult spawners or in trapping juvenile migrants.

Figure 6. Puget Sound Chinook VSP Monitoring Scores. Scores higher than 69 are considered good, 69 to 50 moderate, and 49 or less inadequate.



Chinook salmon are the most important salmon species in Puget Sound in regard to its economic importance as a sport fish and food fish for tribal and commercial fisheries. It is also important in the diet of killer whales. It has been extensively monitored for well over fifty years as a crucial component of the coastal fisheries of the northeastern Pacific Ocean from California to Alaska. Much of the data collected over the years was derived from ongoing fisheries and reported through the Pacific Salmon Treaty requirements and the Pacific Fishery Management Council created by the Magnuson Act. The use of coded wire tags inserted into the snouts of hatchery released salmon fingerling and yearling smolts has provided most of the information on catch composition migration patterns and cohort age structure. With the listing of Puget Sound Chinook as threatened under the federal Endangered Species Act, the information needed about life history has shifted to naturally produced fish within the historic Chinook producing streams and populations within the Sound.

Status of Adult Abundance Estimates

Prior documentation of the methods for estimating spawner abundances is scattered in multiple reports produced by the WDFW and the tribes. The previous summarized report of abundance monitored was produced by (Smith and Castle 1994) and is valuable for determining changes in methods over the past 20 years. More recently the co-managers produce an annual post season harvest report that briefly describes methodologies.

Redd Counts

Determining adult spawner abundance is the single most important measure of Chinook status. The almost universal approach in Puget Sound is to determine the number of adults by counting the number of redds created in the river on a weekly or bi-weekly basis over the spawning period. This is then used to create a relationship based on the cumulative total number of redds and the estimated number of fish associated with an individual redd and the number of redds per female. This procedure, known as Area Under the Curve (AUC) varies from stream to stream depending upon the amount of flights versus ground counts and whether the entire area accessible to spawning Chinook is surveyed or only index areas that are extrapolated to the entire spawning area. A comparison of the adult abundance methods for each river is found in Table 2. Sources of error in these estimates include:

1. Unmarked hatchery fish are counted as wild fish.
2. Sex ratio estimates are old or inaccurate. Most are based on 1976 data.
3. Fish or redds are not visible due to water conditions or weather or the survey is scrubbed entirely.
4. Other spawning fish such as pink salmon confuse the results on odd years and may result in over or under estimates in some areas.
5. Individual redds are often not specifically identified and marked but are identified based on estimated redd visibility time span. Redd visibility time span is not estimated each year but a standard 21 days is usually applied.
6. Information on the number of false redds (redds with no eggs) is not available.
7. Number of fish per redd is in error either due to lack of valid annual measurements or the statistic used is based on old data not recently verified. Nearly all sites in the Puget Sound used an estimate of 2.5 fish per redd based on a 1973 study in the Skagit River basin.
8. Index area redd counts are not representative of the total spawning area. The sites may vary from year to year based on accessibility and visibility. Many redd index sites were calibrated in the past but their current relationship to the entire spawning area and total number of redds is not known.

In all of the TRT populations surveyed in Puget Sound where spawner abundance estimates were based on redds no estimates of precision were available. Therefore, there are no confidence limits around the data to indicate how much trust should be placed on the estimated run sizes. Scoring reflects this lack of precision information with redd count scores of four to six. (Hahn, et al. 1998) and (Hahn, et al. 2001) attempted to measure precision and variance of Chinook estimates in the Skagit, Stillaguamish and Green Rivers and suggested methods that could be employed to measure variance but these have not been implemented by the co-managers. (Parsons and Skalski 2009) reviewed the statistical problems

with using various techniques for estimating escapements. Redd counts were considered inaccurate due to lack of data on the number of false redds and sex ratios.

Only the Skagit, Cedar, and Green received a perfect score of 10 based upon a full census of the spawning area and specific locations recorded by GPS for each redd. These estimates still contain variances not estimated for fish/redd and redds/female. Many of the proposed highest priority monitoring additions found in this report are designed to improve the estimates of adult spawners that uses redd surveys.

North Fork Nooksack has the lowest score because the surveys are affected by water clarity from glacial flour and flow as well as the other factors outlined here. However, Nooksack measures do take into consideration and subtract out hatchery strays. Overall Chinook adult spawner abundance scores are lower than expected with an average score of 6.27 for twenty two populations.

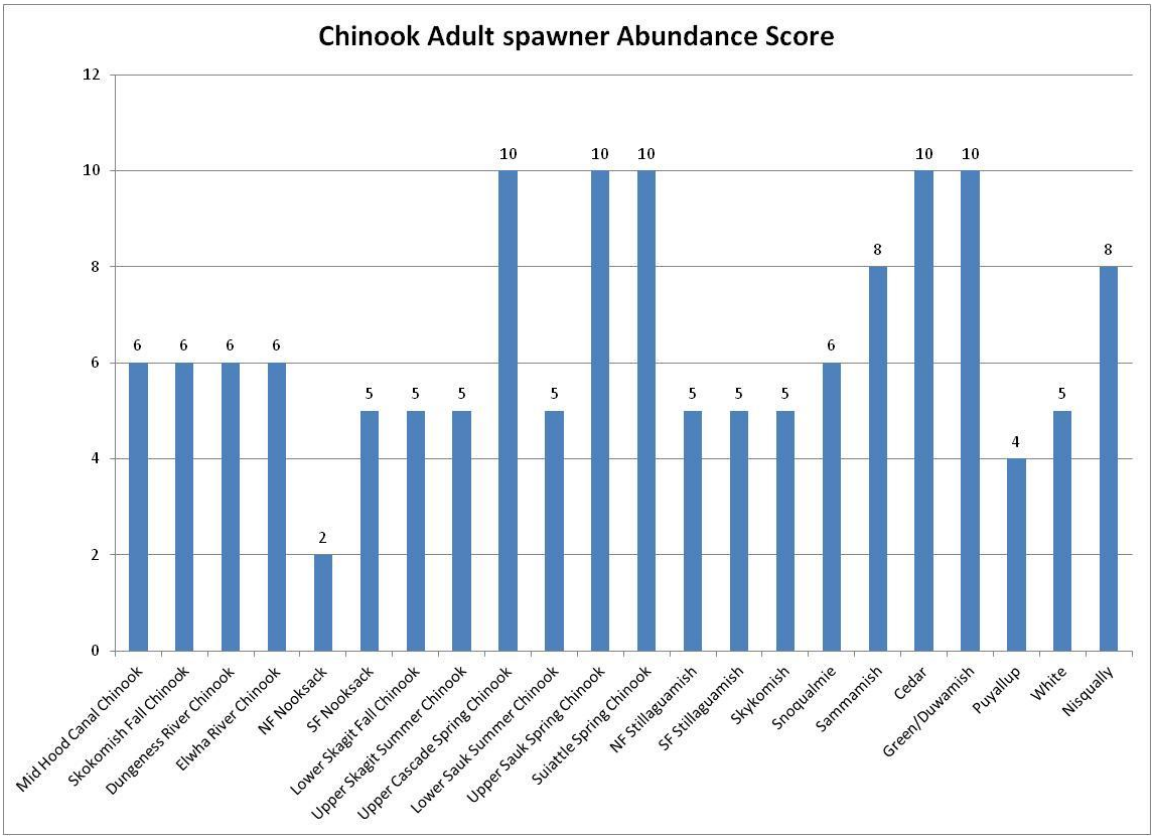


Figure 7. Chinook adult spawner abundance score

Mark-Recapture Musslewhite (Musslewhite 2010) recently attempted to perform mark-recapture estimates of Chinook in the Skagit and Snohomish systems such that they would have a CV of

<15%, but attempts were not successful because they could not trap enough adults in the lower river to obtain a sufficient sample size.

Weirs and Dams A few areas are trying different approaches such as in the Elwha River where a floating weir is employed in conjunction with a DIDSON sonar counter to try to calibrate estimates of adult Chinook passing the location near the mouth. Precision estimates have been made at this site in the past two years (CV<17%). Also, the new floating weir installed in the Nisqually River should provide good point estimates of fish passing the weir. Both of these weirs have to contend with trying to determine pre-spawn mortality after passing through the weirs and the percentage of spawners that spawned downstream of these structures. The same problems also arise at the Hiram Chittenden Locks leading into Lake Washington, Cedar and Sammamish Rivers, and for fish counted at the Buckley Dam trap on the White River.

Genetic Mark Recapture:

Washington Department of Fish and Wildlife geneticists have teamed with WDFW and tribal field biologists to implement several Chinook salmon genetic mark-recapture (GMR) projects. In GMR's simplest form, genetic samples are taken from adults, either at a trap or from spawned-out carcasses, and from subsequent out migrating juvenile offspring. Parentage analyses are used to link the juveniles to spawners, and then mark-recapture statistics are used to estimate escapement or numbers of spawners. With the input of additional information (e.g., mark-status of adult fish) these programs can be expanded to include, for example, relative reproductive success, measured at various life-cycle stages.

If successful it has the capability of determining not only adult abundance but also other VSP information such as genetic diversity, sub populations within a watershed, spatial distribution of specific adults and their offspring and marine survival. Pilot projects are now being implemented in the Stillaguamish, Snohomish, and Green rivers, and in the Coweeman River in the lower Columbia Basin. The Puget Sound projects are funded through the Pacific Salmon Commission's Sentinel Stock Program.

Due to water clarity problems from glacial flour within the Nooksack watershed, managers are looking for alternative solutions to obtain valid adult abundance estimates. Therefore, one of the highest priorities for Nooksack Chinook is to implement a genetic mark-recapture project.

Probabilistic Geospatially Referenced Tessellated Sampling (GRTS):

This approach uses a randomized probabilistic sampling pattern to sample redds or fish throughout a watershed such that an estimate of the full watershed can be expanded from the known proportion of the spawning area. The advantage of this approach is that it is not biased to index sites, it has known precision with confidence intervals, and it samples the entire spawning area such that it can detect changes in spatial distribution (Courbois, et al. 2008). This procedure has been used successfully by the Oregon Department of Fish and Wildlife and some Columbia River treaty tribes. Discussions with the Puget Sound co-managers have not been met with much enthusiasm because it has not been tried

on an ongoing basis in Puget Sound. Also, all previous Puget Sound data have been based on redd counts of index sites or specifically identified spawning portions of the watershed and there may be difficulties in resolving effects upon long term data sets. Table 2 provides an overview of the current adult spawner methods and their strengths and weaknesses.

Table 8. Puget Sound Chinook Adult Spawner Methods

TRT Population	Adult Abundance Method	Is CV value <16%	Fish per Redd	Survey Frequency	PNOS Estimated?
Hood Canal MPG					
Mid Hood Canal	AUC Redd Index Counts Hamma Hamma, Duckabush & Dosewallips	Not estimated	2.5 Assumes a sex ratio of 1.5:1 but this is not checked.	7-10 days August through October	Hamma Hamma only
Skokomish Fall	AUC Redd Index	Not estimated	2.5 Assumes a sex ratio of 1.5:1 but this is not checked.	7-10 days	Yes
Juan De Fuca MPG					
Dungeness Fall	Redd census. All redds are marked with flag and GPS located	Census	2.5 based on 1976 Skagit River study. Assumes a sex ratio of 1.5:1 but this is not checked.	7-10 days August through October	Yes Carcass and broodstock collection
Elwha Fall	AUC Redd & Didson & Weir	17% Didson No for AUC	2.5 Assumes a sex ratio of 1.5:1 but this is not checked.	7-10 days 21 day redd life	Yes based on otolith marks
Georgia Strait MPG					
NF Nooksack	Redd count and carcass count index sites depending upon water clarity.	Not estimated	2.5 or carcass expansion factor 3.48	1-8 times per season	Yes Carcass and broodstock collection
SF Nooksack	Combination of Redd Counts and apportionment of carcasses by stock origin over entire spawning area	No. There is conflict between redd count estimates and DNA parental information	2.5 Assumes a sex ratio of 1.5:1 but this is not checked.	July-September	Yes Carcasses identified by external marks. Not marked is identified using DNA genotype.
North Sound MPG					
Lower Skagit Falls	Aerial redd counts every 14 days Tributary counts added based on water clarity	Not done. One time estimates by Hahn et al. 2001	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	21 day redd life based on 1973 data. No test redds used.	Yes. Derived from CWT sampling of carcasses.
Upper Skagit Summers	Aerial redd counts every 14 days Tributary counts added based on water clarity	Not done. One time estimates by Hahn et al. 2001.	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	21 day redd life based on 1973 data. No test redds used.	Yes. Derived from CWT sampling of carcasses.
Upper Cascade Springs	Complete redd census of all available spawning areas every 14 days. All redds marked	Assumed Census. No CV values	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	All redds marked	Yes. Derived from CWT sampling of carcasses.
Lower Sauk summers	Complete redd census of all available spawning areas every 14 days. All redds marked	Assumed Census. No CV values	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	All redds marked	No. Not enough fish to determine status
Upper Sauk	Complete redd census of all available spawning areas every 10 days. All redds marked	Assumed Census. No CV values	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	All redds marked	Yes. Derived from CWT sampling of carcasses.
Suiattle	Complete redd census of all available spawning areas every 10 days. All redds marked	Assumed Census. No CV values	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	All redds marked	Yes. Derived from CWT sampling of carcasses.

TRT Population	Adult Abundance Method	Is CV value <16%	Fish per Redd	Survey Frequency	PNOS Estimated?
NF Stillaguamish Summer-fall	Aerial and ground redd counts.	Considered a census. Hahn et al 2001 estimated CV in between 0.111-0.292 in 2000-2001.	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	7-10 days August through October	Yes. Derived from CWT sampling of carcasses by survey reach.
NF Stillaguamish Summer-falls	PSC Sentinel Stock Program is implementing experimental use of adult and juvenile GMR parentage analysis to obtain unbiased adult abundance estimate 2011-2013	Yes, based on 3 years of data (2008-2010)	Not calculated	7-10 days August through October	Increased sampling of NOS needed
SF Stillaguamish falls	Foot and float redd surveys plus some aerial counts. Some tributaries counted and added to total.	Not estimated	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	Sept-October	Yes. Derived from CWT sampling of carcasses by survey reach.
Skykomish	Redd counts using AUC model compared to fish counts at Sunset Falls. All redds marked PSC Sentinel Stock Program is implementing experimental use of adult and juvenile GMR parentage analysis to obtain unbiased adult abundance estimate 2011-2013	Not estimated	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	Ground 7-10 days Aerial every 14 days. All redds marked.	Yes. Derived from carcasses expected 90% ± 8% certainty
Snoqualmie	Redd counts using AUC model. PSC Sentinel Stock Program is implementing experimental use of adult and juvenile GMR parentage analysis to obtain unbiased adult abundance estimate 2011-2013	Not estimated	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	Ground 7-10 days. All redds marked Aerial every 14 days.	Yes. Derived from carcasses .expected 90% ± 8% certainty
Central-South Sound MPG					
Sammamish	Index counts in select tributaries. Redd census combined with complete carcass counts.	Not estimated	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	Ground 7-10 days Assumes 21 days redd life.	Yes. Derived from carcasses CWT
Cedar	Counts above Landsburg dam and Lower river AUC redd counts	No calculated precision	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	Ground every 2-3 days	Yes. Derived from carcasses CWT and Landsburg dam
Green/Duwamish	Redd counts of entire river using foot and float counts. River is also flown 3 times. Hydro-acoustic monitoring has been conducted in a few years but is not effective in years with large numbers of pink spawners.	No calculated precision because it is considered a 100% census due to low numbers of fish...	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	Ground 7-10 days	Yes. Derived from carcasses CWT.
	PSC Sentinel Stock Program is implementing experimental use of adult and juvenile GMR parentage analysis to obtain unbiased adult abundance estimate	CV <15% for 2010	Not directly calculated by this method	Study may be conducted for 3 spawning years, 2010-2012	

TRT Population	Adult Abundance Method	Is CV value <16%	Fish per Redd	Survey Frequency	PNOS Estimated?
Puyallup	Redd counts on even years and AUC method on odd years. An adjustment factor is used based on number of pink salmon. Tributaries use a variety of methods Current Didson is not able to discern between different species and is in the lower river downstream of White River confluence RM 6.6.	Not estimated	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	Ground 7-10 days	Yes. Derived from carcasses CWT .by reach
White	Fish are counted at Buckley dam trap and White river Hatchery trap. Index surveys are conducted upstream and downstream of the trap	Not estimated	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	Ground 7-10 days	PHOS & PNOS based on Buckley trap information
Nisqually	A new weir will be used in 2012 that will span the entire Nisqually and provide estimates of adult upstream migrants Total escapement estimated from redd counts in main stem Nisqually (RM 21.8 to 26.2) and from peak live plus dead fish counts in Mashel River up to RM 3.2.	Weir will need to be calibrated for efficiency Not estimated	2.5 Assumes a sex ratio of 1.5:1 No observations used to verify fish/redd.	Weir trap will be operated on a daily basis from July through October	PNOS will be estimated at the weir. Uses a combination of spawning ground surveys using jaw tags to estimate weir trap efficiency.

Status of Juvenile Abundance Estimates

Juvenile migrant traps are in operation in every MPG in Puget Sound with 19 of 22 populations having estimates of Chinook freshwater migrant production. All of these traps have been calibrated by mark recapture of actively migrating Chinook and both yearling and 0+ migrants are enumerated. Most of these estimates have CV values within the NOAA Fisheries guidelines for age 0+ Chinook. This results in the ability to determine the overall freshwater productivity of the watersheds and whether habitat improvements are increasing freshwater survival and production. This can only be done when freshwater habitat status/trend information is created that tracks both improvements and degradation to the watersheds. For those watersheds with scores of 3, there are either problems with calibrating the trapping efficiency, or there are problems with not trapping the entire migrant period or the entire TRT population.

Another factor that is being addressed is that many of the migrant traps have combined estimates for two or more TRT populations. This is true for the Nooksack, Stillaguamish, and Skagit. For these watersheds genetic methodologies are either planned or underway in order to parse out the relative contributions of each basin's populations to the trapped out-migrants.

In-stream estimates of juvenile freshwater densities are not done as part of routine monitoring, but have been done in the past as part of addressing critical uncertainties in specific watersheds.

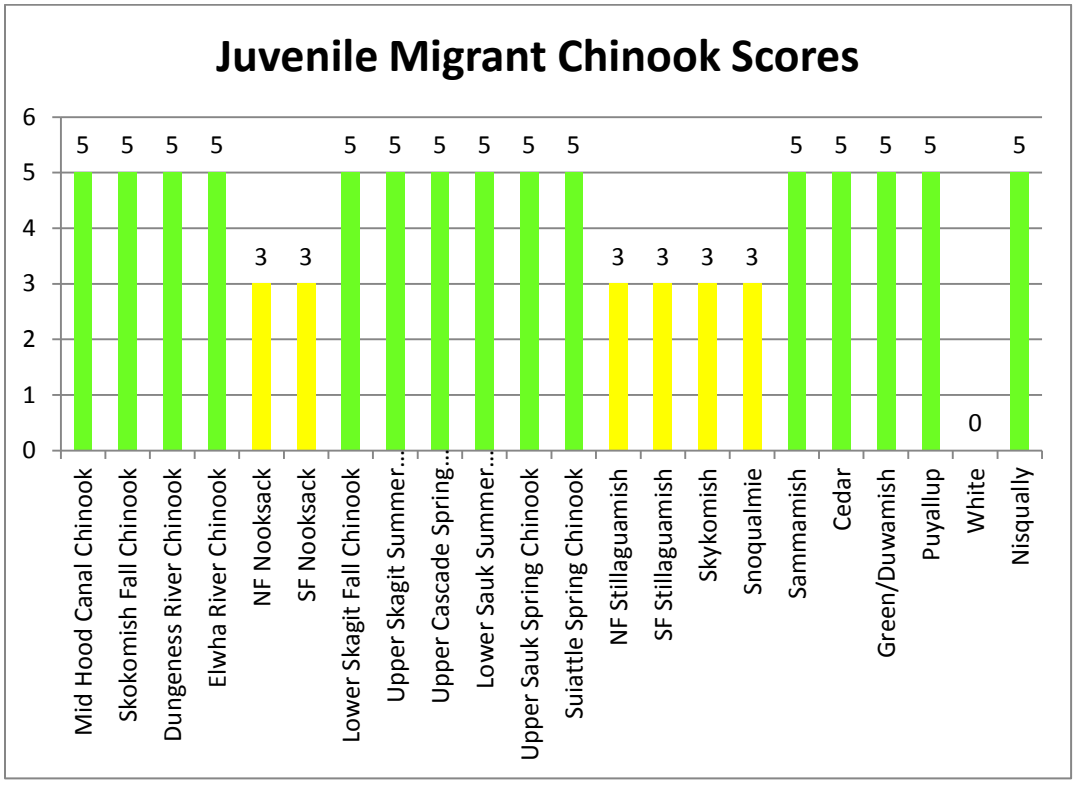


Figure 8. Chinook juvenile migrant monitoring scores where a 5 is good. Skagit, Nooksack, and Stillaguamish populations are a composite score and cannot be parsed out at this time.

Table 9. Juvenile migrant trap locations, time frames, and quality

TRT Population	Juvenile migrant Trap Present	Trap is Calibrated CV value calculated	Trap Duration	Estimate of out-migration available
		Hood Canal MPG		
Mid Hood Canal	Screw trap Hamma Hamma & Duckabush	CV range 6.5 – 21.7% 2002-2011 for age 0+ Chinook (Hamma Hamma only)	January-July	Yes
Skokomish Fall	Screw trap	No	Partial	No
		Juan De Fuca MPG		
Dungeness Fall	Screw trap	Yes 5.8 – 12.8% CV 2005-2011 for age 0+ Chinook	February-August	Yes
Elwha Fall	Screw Trap	Yes 9.7 aver. CV 2005-2009 for age 0+ Chinook	February-June	Yes
		Georgia Strait MPG		
Nooksack (Composite of NF and SF)	Screw trap lower river captures both forks	Not calibrated for all flows No CV value.	Dec-November	Yes. Composite estimate based on recapture of fish released from hatcheries upstream
		North Sound MPG		
Skagit (Composite of Skagit, Cascade, Sauk, Suiattle)	Screw trap and scoop trap lower river captures all populations	0.8%-15% CV 1994 - 2011 for 0+ Chinook. No CV for 1+ age group	April-June	Yes. Composite estimate based on recapture of fish released upstream of trap
Stillaguamish (Composite of NF and SF)	Screw trap in lower river	CV value estimated but not provided	Operated 25% of the time	Yes. Can separate fall and summer runs using DNA
Skykomish	Screw trap	CV value estimated but not provided	January-June 35% of time	Yes. Based on recapture of dyed fish released upstream
Snoqualmie	Screw trap	CV value estimated but not provided	February-June 35% of time	Yes. Based on recapture of dyed fish released upstream
		Central-South Sound		
Sammamish	Screw & scoop traps on Bear Creek	3.9 – 10.9% CV 2001-2011 age 0+ Chinook	February-July	Yes based on recapture of marked releases done weekly
Cedar	Screw trap	4.4 – 17.6% CV 1999-2011 age 0+ Chinook	January-July	Yes based on recapture of marked releases done weekly
Green	Screw trap upstream of Soos Creek	5.0 – 21.0 % CV 2000-2011 age 0+ Chinook	January-July	Mark recapture for Chinook done on a weekly basis.
Puyallup (Does not include White)	Screw trap at RM 10.6	CV 2-12% with average of 7%.	January-August	Calibration using mark recapture from hatchery fish placed 1/4 mile upstream from the trap.
Nisqually	Screw Trap at RM 13.5	3.3 – 9.4% CV 2009-2011 age 0+ Chinook; 19.5 – 47.7% CV 2009-2011 age 1+ Chinook.	January-August	WDFW uses weekly mark recapture of migrants both age 0+ and yearlings marked with dye and fin clips and taken upstream one mile for release.

Adult Productivity Calculations

Adult productivity estimates rely upon the ability to reconstruct the life history cohorts of each adult salmon run. This includes information on age, sex ratios, fecundity, size, estimates of natural origin

spawners (NOS) and hatchery origin spawners (HOS). Most of this information is derived from spawned carcasses collected during spawner redd surveys. In some locations adult life history information is being collected at fish hatcheries in conjunction with brood stock programs involving supplementation or maintaining a set proportion of wild spawners in the hatchery program. For most populations, estimates of fecundity are not routinely made and rely upon old numbers. Co-managers rely upon hatchery fecundity as a surrogate for natural fish in most locations. Locations where adult productivity appears to not be possible to calculate include SF Nooksack and Sammamish due to poor abundance information coupled with poor age structure and PHOS information.

Status of Harvest Monitoring

Puget Sound Chinook harvest is described in the Comprehensive Management Plan for Puget Sound Chinook (Comprehensive Management Plan for Puget Sound Chinook 2010). It depends upon exploitation rate monitoring and exploitation rate ceilings to control harvest for each management unit. Exploitation rate ceilings are based on the best available information on the recent and current productivity of each management unit. The harvest objectives for each management unit are stated as ceiling exploitation rates or escapement goals for naturally spawning or natural origin Chinook. Specifying the exploitation rate ceilings and low abundance thresholds for all management units in terms of natural production has been a significant change relative to management practices prior to listing.

The ability to predict the impact of harvest on estimates of naturally produced adult abundance is critical to understanding actual productivity of the population and overall marine survival rates. Since Chinook salmon from Puget Sound migrate north along the coast of Canada and Southeast Alaska, the cumulative impact of all commercial and sport fisheries upon the population must be determined because treaties, councils, and fisheries plans are at stake.

Fishing rate estimates are derived from the Pacific Salmon Commission (PSC) Chinook Technical Committee (CTC) for coast-wide interceptions. Exploitation rate analysis and harvest rate are calculated for two fishery groups: mixed maturity (ocean) fishery and mature (terminal) fishery areas. Fishing rates are age specific. The fishing rates are derived from coded wire tagged indicator hatchery stocks and represent the portion of the age specific standing stock taken by the fishery. The estimates from the PSC CTC include both landed and incidental mortalities. The Chinook FRAM indicator stocks for Puget Sound are as follows:

North Puget Sound Natural Summer/falls

1. Nooksack- Based on double index tagging (DIT) of Samish Hatchery summer/fall Age 0 stocks.
2. Skagit- Based on DIT tagging of Marblemount Hatchery summer Age 0 stocks.

North Puget Sound Natural Springs

1. Nooksack- Based on DIT tagging of Kendall Cr. Hatchery spring Age 0 stocks.
2. Skagit-Based on DIT tagging of Marblemount Hatchery spring age 0 and age 1 stocks.

Central Puget Sound Summer/falls

1. Stillaguamish- Based on DIT tagging of Stillaguamish Tribal Hatchery summer Age 0 stocks.
2. Lake Washington- Based on DIT tagging of UW Hatchery accelerated summer/fall Age 0 stocks now discontinued.
3. Green River (South Puget Sound Fall Fingerlings)- Based on DIT tagging of Soos Cr. & Grovers Cr. Hatchery summer/fall Age 0 stocks.

South Puget Sound

1. South Puget Sound Fall Yearlings- Based on DIT tagging of Tumwater Falls Hatchery summer/fall Age 1 stocks.
2. White River Spring Yearling- Based on DIT tagging of White River Hatchery spring Age 1 stocks.
3. Nisqually Fall Fingerling- Based on DIT tagging of Clear Cr. Hatchery summer/fall Age 0 stocks.

Hood Canal Summer/Fall

1. Based on DIT tagging of George Adams Hatchery summer/fall Age 0 stocks.

Juan De Fuca Summer/Fall

1. Based on DIT tagging of Lower Elwha Hatchery summer/fall Age 0 stocks.

Since recovery of coded wire tags from hatchery released fish has been the basis in the past for determining stock interceptions coast-wide, the actual impact upon naturally produced populations is in most streams difficult to determine because there are fewer fish produced and migrating to the sea. In most cases the naturally produced fish are not coded wire tagged or otherwise easily identified in commercial and recreational fisheries.

Questions about whether using hatchery stocks as surrogates for natural origin Chinook produces valid estimates have led to exploring the use of DNA as stock indicators in the mixed stock fisheries. This can be done if a representative baseline is developed for natural origin populations within the TRT populations within Puget Sound. They must have sufficient genetic diversity so that the different river systems can be identified based on their gene markers.

In December of 2006, members of the PSC's Committee for Scientific Cooperation (CSC) submitted a proposal to the Northern and Southern Restoration and Enhancement Funds for workshops devoted to assessing the potential for using Genetic Stock Identification (GSI) methods for management of ocean salmon fisheries (GSI Steering Committee of the Pacific Salmon Commission 2008). Their report summarized the issues by stating that "*Genetic methods allow direct estimation of the stock compositions of fisheries, both for landed catch or for fish that are caught and released, either in-season or post-season. However, genetic methods are not presently capable of providing data required for coast-wide cohort reconstruction and, therefore, stock-age-specific exploitation rates, especially for species like Chinook salmon that have multiple ages at maturity.*"

Annual estimated impacts of proposed ocean and terminal fisheries on Chinook are determined by the Fishery Regulation Assessment Model (FRAM) used by the Pacific Fishery Management Council (PFMC). The Chinook FRAM evaluates impacts on a majority of stocks originating from Willapa Bay, north Washington Coast, Puget Sound, and southern British Columbia as well as the Columbia River, north-

central Oregon coast and California Central Valley (Sacramento River). FRAM is used to evaluate the impacts of proposed fisheries for compliance with management objectives, allocation arrangements, Endangered Species Act (ESA) compliance, and domestic and international legal obligations. The objective of FRAM is to provide a single common tool that can support both domestic and international fishery planning processes using a common set of data and assumptions (PFMC Fishery Regulation Assessment Model (FRAM): An Overview for Coho and Chinook 2008).

Used to predict impacts from a variety of proposed fishery regulation mechanisms in a single management year, FRAM is a single-pool, deterministic computer model that estimates fishery related mortality and spawning escapement by stock for specific time periods and age classes. FRAM contains 76 Chinook stock groups that were chosen based on their contribution rate to PFMC fisheries, the availability of CWT recoveries, and the level of management interest (2008). Seventy-three pre-terminal and terminal Chinook fisheries are included from southeast Alaska, Canada, Puget Sound and along the coasts of Washington, Oregon and California. A time step structure is used in FRAM that corresponds with management planning fishery seasons and species-specific migration and maturation schedules. Four time periods are represented for Chinook. At each time step, Chinook cohorts are subjected to natural mortality, pre-terminal fisheries, maturation, and terminal fisheries (2008).

Estimations of fishery impacts, such as exploitation rates, are dependent on CWT recoveries. Decreasing the number of CWT recoveries increases the variance of the estimated exploitation rates by time and area strata. In order to address these data limitations, efforts were made to restrict time steps in the model to only those necessary for fishery management purposes. Assumptions and limitations to the FRAM model described in the PFMC *Fishery Regulation Assessment Model (FRAM): An Overview for Coho and Chinook – v 3.0* (2008) include:

1. *CWT fish accurately represent the model stock.* For almost all populations, natural origin stocks are aggregated with hatchery stocks and both are represented by the hatchery stock's CWT data. For each modeled stock aggregate, it is assumed CWT data accurately represents the true exploitation rate and distribution pattern of all the untagged fish in the modeled stock. For a few stocks, such as Skagit and Stillaguamish summer Chinook, juveniles from wild broodstock are CWT'd and released to represent the natural origin fish in fishery exploitation estimates.

2. *Length at age of Chinook is stock specific and constant from year to year.* Parameters for Chinook growth curves are estimated from data collected over a number of years. Growth in the year to be modeled is assumed to be similar to that in the years used to estimate the parameters.

3. *Natural mortality is constant from year to year.* Rates for Chinook are assumed to be constant across months, age specific and represent the same annual rate used in the Pacific Salmon Commission (PSC) Chinook model.

4. *Stock distribution and migration is constant from year to year and is represented by the average distribution of CWT recoveries during the base period.* Data on annual variability in distribution and migration patterns of Chinook stocks are lacking so fishery-specific exploitation rates are

computed relative to the entire cohort. Differences between distribution and migration patterns of stocks will decrease the accuracy of the model estimates of stock composition and stock-specific exploitation rates for the modeled fishery.

5. *No multiple encounters occur with the gear by the fish in a specific time/area/fishery stratum.* Fish are assumed to be vulnerable to fishing gear only once in the model. Large selective fisheries or longer time intervals (which increase the likelihood that a fish will encounter fishing gear more than once) may increase potential bias in the model.

The sources of error for the above assumptions are easily surmised. They include:

- CWT hatchery releases may not migrate in the same manner as natural stocks from the same river and may not behave in coastwide fisheries in the same manner thus affecting encounter rate.
- Length at age varies from year to year based on ocean productivity and food availability. Therefore, the FRAM model is always correcting any differences in size after the fact.
- Natural mortality is not constant from year to year as has been well demonstrated in the studies of North Pacific decadal oscillations in sea temperature and its affect upon salmon returns coastwide. Also, numerous studies show that hatchery fish do not survive as well as natural fish after release.
- Stock distribution and migration patterns may not be the same from year to year. It is well known with sockeye that on some years the major Fraser run passes through the Strait of Juan de Fuca while on other years they divert through the Johnston Strait on the eastside of Vancouver Island. It is known that Nooksack Chinook migrate both through the Strait of Juan de Fuca and the Johnston Strait. How, when, or what influences these changes is not clearly understood.
- Multiple encounters may occur both in selective sport fisheries but also in some net fisheries where tidal fluctuations and currents may move fish through an area multiple times.
- CWTs may not be consistently detected in some fisheries and on the spawning grounds leading to error in estimating total returns and harvest interceptions.

Although primarily used as a preseason fishery assessment tool, FRAM can provide post-season estimates of fishery impacts using observed catches and actual spawning escapements (or terminal run size). CWT recovery data used in FRAM is primarily from a period in the late 1970's to early 1980's of broad open-season fisheries and expanded CWT release programs. Therefore, estimates from FRAM assume similar catch distribution and exploitation patterns as those in this period. Exploitation rate analysis from annual cohort reconstruction of CWT release groups provides the most reliable estimate of fishery impacts on recruitment for a particular spawning year. However, in many cases, annual CWT release programs do not exist or have been discontinued in which case FRAM is the best tool to estimate actual fishery impacts on stocks.

The Fishery Regulation Assessment Model (FRAM) calculates recruits prior to harvest for natural populations based on CWT marine survival estimates from hatchery surrogate wild stock releases of 0+

and 1+ Chinook. Because the Skagit, Stillaguamish, Snohomish, and other runs are predominantly wild, some hatchery fish are raised and released with double index tagging so that coastal interception information is available as well as marine survival estimates. Double index tag recoveries so far have only been used to evaluate escapement rates between unmarked and marked (AD clipped) fish from mark select fisheries.

Problems associated with estimating the effects of harvest on natural Chinook were identified for Nisqually, Nooksack, Samish, Snohomish, and Stillaguamish. Nooksack spring Chinook forecast information is used to calibrate the CTC model but there is no new data since 1987. Nooksack fall (Samish) does not provide preseason or post season age specific information in recent years so the 2001-2002 return rates is used in the model. No estimates of Nooksack yearling catch in the various coastal fisheries are available after 1999.

For the Nisqually River Chinook population the indicator hatchery stock is from the Clear Creek or Kalama Creek hatchery. The previous lack of ability to accurately parse out hatchery and natural components has affected the harvest estimated for natural Chinook in the Nisqually. The weir should help clarify the true impacts in the future.

For each Stillaguamish or Snohomish terminal fishery, the base period preferred fishery exploitation rate is multiplied times run size and a fishery scalar to arrive at the harvest. If a stock is a mix of hatchery/wild origin, i.e. Snoqualmie and Skykomish, impacts are split by pre-season forecasted or post-season estimated proportions of hatchery and natural. Terminal fisheries are not modeled using the stock specific exploitation rate approach described above. In the terminal areas, biologists either provide a fixed catch or a harvest rate which is assigned 100% to the local stock and then split into hatchery/natural components based on preseason or post season run proportions. If targeting hatchery stock only (Skykomish mark selective fishery (MSF)) additional adjustments are made.

To split Stillaguamish catches and escapements into North Fork and South Fork impacts, the pre-season forecasted or post-season estimated ratio is used. Since both components are assumed to experience the same exploitation rate, the Stillaguamish is not split in TAMM into NF/SF to compute separate exploitation rates; but this stock is split in TAMM into NF/SF to show the escapement for each component.

Status of Hatchery Effectiveness Monitoring Programs

Hatchery programs have been identified as a listing factor for Puget Sound Chinook and are being addressed through individual hatchery genetic management plans (HGMP). This assessment did not try to address those actions identified in that process and any monitoring associated with hatchery operations. However, some hatchery programs are either being monitored for their effectiveness in terms of contributions to improved abundance, genetic diversity, expansion of spatial distribution, or productivity.

Some of the gaps identified for additional monitoring address hatchery issues and are listed below. The hatchery programs listed do not include all programs at those hatcheries but those that have ongoing monitoring or proposed monitoring affecting VSP.

Hatchery Integrated Harvest Programs

Kendall-North/Middle Fork Chinook

The goal of this program is to use indigenous stock and release up to 750,000 fingerling spring Chinook to restore spring Chinook salmon in the North Fork Nooksack River to self-sustaining level of 2,000 natural origin recruit spawners. Survival and contribution of the supplemented fish to the natural origin spawning population is estimated each year. Data are also collected on run timing, spawn timing, and age and sex composition. They are also sampled for marks and CWTs. Each production group is identified with distinct otolith marks, adipose clips, coded wire tags, blank wire tags or other marks. Genetic profile of the stock is also monitored.

A GMR project is matching adult carcasses to migrating smolts and can provide an estimate of hatchery/natural origin contribution to the smolt generation. Full-parental genotyping of the hatchery broodstock would expand ability to detect hatchery contribution to natural-origin smolts.

Marblemount Hatchery

Hatchery straying in the Skagit River basin can affect spawner abundance estimates and genetic diversity. WDFW and the tribes are evaluating the hatchery stray rate by conducting carcass surveys in the vicinity of the Marblemount hatchery during spring Chinook spawning time, and using the tags recovered from these surveys to calculate the percentage of Skagit hatchery spring Chinook escapement that spawns in the wild. Marblemount hatchery releases of indicator stock double index tagged (DIT) Chinook may be affecting overall Skagit genetic fitness. A Skagit River relative reproductive fitness study may be merited based upon continual use of hatchery product mined from wild stock for use as an indicator stock at Marblemount hatchery. Proposal #33 would evaluate the Spring Chinook supplementation program using a before after (BA) or before after control impact (BACI) design.

Samish Hatchery

Straying of program-origin (Green R. stock) fish into natural spawning areas used by the native South Fork Nooksack and North Fork Nooksack Chinook populations has been raised as an issue. Concern is focused on monitoring gene flow on the spawning grounds and whether the hatchery program is negatively affecting overall population diversity of Samish Chinook. No monitoring at this time.

Lummi Sea Ponds

Lummi Tribe has an ongoing study of their Lummi Bay hatchery program using a mark sample recovery and monitoring effort as part of hatchery reform.

Skookum Creek

The overall goal of the supplementation program is to increase the natural spawning population of South Fork Nooksack river early Chinook while minimizing the effects of hatchery intervention on the genetic integrity of the stock. The long term goal is to continue supplementation until the habitat is restored to a level that will sustain a viable natural origin population. Program began 2006. Release goal is 200,000 sub-yearling Chinook. All supplemented fish are marked and tracked through spawner surveys, hatchery rack, and fisheries.

A GMR project is matching adult carcasses to migrating smolts and can provide an estimate of hatchery/natural origin contribution to the smolt generation. Full-parental genotyping of the hatchery broodstock would expand ability to detect hatchery contribution to natural-origin smolts.

Wallace River Hatchery

An evaluation is underway to determine the effect that Wallace River hatchery straying and spawning is having on natural populations. The Wallace River Hatchery (South Fork Skykomish Chinook) program is an integrated harvest program that also supplements natural Snohomish Chinook populations. A coalescent model of gene flow between summer and fall populations in the Snohomish has been constructed. Hatchery samples have been put into this model. Plans are being formed to use genetic parentage methods to assign smolts and subsequently returning adults to hatchery- and natural-origin carcasses sampled out of the river to estimate relative reproductive success of hatchery fish that stray into the river. Current monitoring proposals would procure and install thermal marking system at Wallace River Hatchery to improve estimate of genetically effective PHOS gene flow (proposal #74).

Minter Creek Hatchery

There is an ongoing assessment of fishery enhancement group blackmouth fishery enhancement stocks by WDFW. This study is attempting to determine extent of contribution to resident Chinook populations and possible impacts. No new proposals.

Nisqually Hatchery

Nisqually Chinook hatchery production is transitioning from a segregated program to a smaller scale integrated hatchery program to generate brood stock to support the harvest program and to provide a demographic safety net in years of critically low adult abundance. The total brood stock goal is 420 adults with 25% of the broodstock of natural origin (pNOB). Natural origin recruits (NOR's) will be collected at the new mainstem weir. Smolt releases are projected at 400,000 - 600,000 fish, dependent on sufficient natural-origin returns. All releases will be coded wire tagged, some will have adipose fins clipped for the DIT program and most will be unclipped. .

The stepping-stone hatchery program will be implemented to provide harvest using brood stock collected from the integrated program return. A stepping stone approach was coined by the HSRG to describe a gradual transition from segregated to integrated stock. The total brood stock goal of 2,300 adults would be planned to be taken from integrated hatchery return. The ultimate goal would be a

smolt release of 3.4 - 3.6 million, dependent on size of integrated program. All fish will be marked with 100% adipose fin clip and 100,000 with a CWT/adipose fin clip.

A relative reproductive fitness study should be incorporated into the integrated hatchery program as it begins to determine effects upon natural population fitness. Does fitness improve over time? See proposal #111.

Hatchery Integrated Conservation (Safety Net) Programs

Elwha Hatchery

The primary strategy for restoring Chinook salmon to the upper Elwha system relies on continued hatchery production of the current Elwha stock. Because only a small portion of the Chinook return is from natural origin spawners, the population depends on hatchery supplementation during this period of reduced available habitat, and increased instability of sediments. However, funding is lacking for the first two years of monitoring of the ten years (two life cycles) the hatchery program is designed to operate. Proposal #20 would fund marking of all hatchery Chinook which would help in tracking range expansion.

Stillaguamish Hatchery

The co-managers have operated a paired watershed study on the North and South Fork Stillaguamish watersheds for the last 20 years with the North Fork watershed receiving supplemented wild origin hatchery fish that return to spawn naturally while the South Fork (fall timed) population has received no supplementation. However, due to the declining runs in recent years to the South Fork, the co-managers have started a captive brood program to save this population from potential extinction and have now started supplementation.

Harvey Creek –Brenner Hatcheries

The goal of the program is to increase the natural spawning population of South Fork Stillaguamish Natural Fall Chinook while minimizing the effects of hatchery intervention on the genetic integrity of the stock. The long term goal is to continue supplementation until the habitat has been restored to a level that will increase productivity sufficiently to sustain a viable natural origin population that can support treaty Indian and non-Indian fisheries. Monitoring includes estimating total HOS and NOS and total run size. Juvenile trap provides data on natural versus supplemented migrating juveniles. Approximately 30 adults are collected annually. Release goal is 45,000 fingerlings.

A GMR project is matching adult carcasses to migrating smolts and can provide an estimate of hatchery/natural origin contribution to the smolt generation. Full-parental genotyping of the hatchery broodstock would expand ability to detect hatchery contribution to natural-origin smolts.

Bernie Kai Kai Gobin Hatchery

The Tulalip Hatchery (South Fork Skykomish Chinook) program is an integrated harvest program (one generation out) that also supplements natural Snohomish Chinook populations. The experimental

design is to examine the effectiveness of the supplementation program. It focuses on annually estimating the survival and contribution rates of the supplementation program to terminal area fisheries, hatcheries and natural escapements and includes: thermally marking one hundred percent of Tulalip Hatchery annual production, sampling twenty percent of commercial Chinook catch weekly, a minimum of ten percent of the catch in each sport fishery each month and one hundred percent of the escapement to Tulalip and Wallace River Hatcheries. An average sample size of 102 Chinook carcasses per year is expected to yield a ninety percent confidence interval for the natural-origin fraction of the natural escapement with an average width of ± 8% of the estimated value using otoliths and coded-wire tags. At the sampling level of 50 fish/week, this design will estimate the annual contribution of Tulalip Hatchery fish to the Area 8D fishery with a 95% confidence interval width of ± 4%, using otoliths.

The Tulalip Tribes annually read otoliths at Tulalip Stock Assessment Laboratory with an error rate of < 5%. Their reported quality control procedure utilizes a sample size such that they are 90% confident that the estimated contribution rate of Tulalip Hatchery Chinook to Snohomish natural spawning populations is within ±8%. They estimate the contribution rate of Tulalip Hatchery Chinook and Coho to the Area 8D fishery such that they are 95% confidence that it is within ± 4% of the estimate. They estimate Tulalip Chinook brood year survival rates and the contribution rate to the Tribal terminal area fishery in Area 8D such that they are 90% confident that they are within ± 0.20% of the true value.

Status of Chinook Nearshore and Marine Monitoring

Nearshore studies have been conducted in a number of locations in Puget Sound for Chinook presence and distribution. However, with the exception of the Skagit nearshore area, few studies have attempted to quantify the density of Chinook. The following chart illustrates where we have had Chinook monitoring in the nearshore and gives some idea of their relative distribution and use. A new group has been organized (*Marine Survival Indicators Workgroup)* to try to develop a Salish Sea basin wide approach to monitoring marine salmon survival indicators. Hopefully their work will be able to provide additional focus to marine monitoring needs.

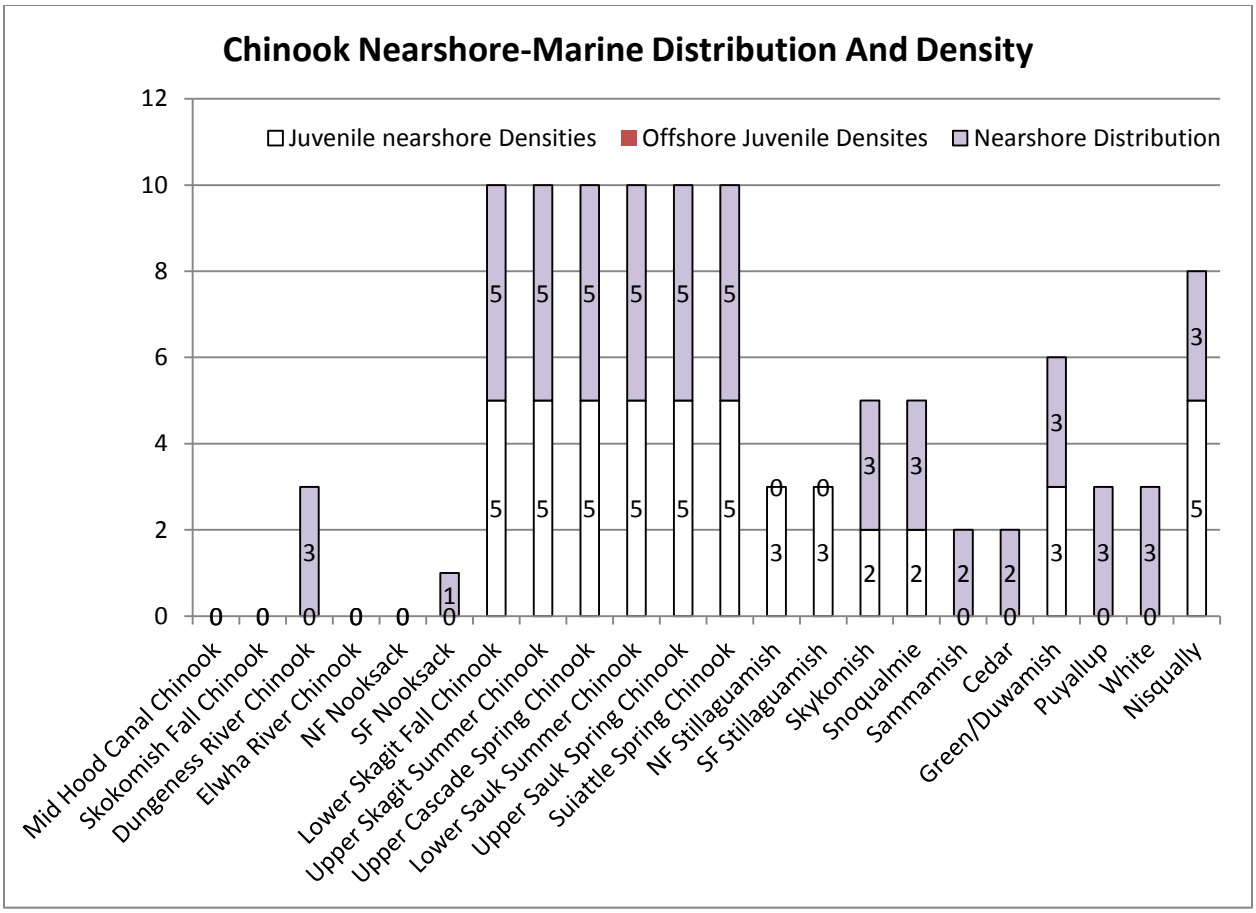


Figure 9. Puget Sound Chinook nearshore and offshore monitoring scores.

Hood Canal MPG

Feller (1974) studied the food habits and movements of chum and pink salmon at Anderson Island, Dabob Bay, and Port Susan in Puget Sound. He found that chum fry stayed in the nearshore areas until they reached a size greater than 60mm when they moved to deeper water. (Bollens, et al. 2010) studied the food habits, distribution and abundance of Chinook, chum, and coho in Dabob Bay from 1985-1987. (Moore, Snyder and Salo 1977) Collected juvenile salmon from several beaches along the west side of Indian Island just outside Hood Canal using a beach seine. Schreiner (1977) sampled the shoreline near Bangor from late March through June 1975 and late January through early June 1976 using beach seine and tow net. A few Chinook were collected in May to July of each year with the peak in late June. The Chinook were observed primarily offshore and only in June and July. Since 2009, general sampling has occurred in northern Hood Canal from the Hood Canal Bridge to Admiralty Inlet for abundance and distribution. They were also beach seined in some areas. The project was funded for only one year.

Juan de Fuca MPG

Elwha River

Beach seine sampling from the mouth of the Elwha River east and also west to Salt Creek has occurred (Shaffer, et al. 2008). Genetic analysis allowed detailed and accurate determination of fish stock origin. They found that 43% of the fish sampled were from Elwha and Dungeness stocks and that 48% represented Columbia River populations. Remaining 9% were from Washington and Oregon coastal populations. Genetic analysis of fish west of Elwha and report is available based on GSI in 2009. This is not a statistically valid sample but good information.

North Sound MPG

Bellingham Bay

Some information has been obtained of the movements and distribution of Nooksack Chinook in Bellingham Bay. Information on residence time has not been able to be estimated at this time.

Skagit Nearshore-Marine

The Skagit nearshore has been studied more than any other area of Puget Sound. Stober and Salo (1970) used tow nets to sample Chinook fry in the Skagit delta, Skagit Bay and along Kiket Island to determine timing and relative abundance. Congleton et. al. (1981) studied abundance and distribution of chum and Chinook in the salt marsh. Larson and Reisenbichler (1994) observed growth increments of Chinook fry from various parts of the estuary as they moved from the river through the salt marsh and then the bay. This demonstrated the importance of the estuary to Chinook growth. (Hayman, Beamer and McClure 1996) sampled six side channel locations and in Skagit Bay. They estimated Chinook timing, size, and densities. More intensive studies of fish use in Puget Sound Skagit delta pocket estuaries began in 2002. At first, research was limited to understanding juvenile Chinook salmon use of sites within Skagit Bay (Beamer, et al. 2003). In 2004, the study expanded to sites throughout the Whidbey Basin, Fidalgo Bay and Samish Bay via a cooperative effort that was partially funded by the Northwest Straits Commission. The focus of this expanded research is to understand landscape scale patterns of fish usage including what species and life history types use these systems, how connectivity or position within the larger landscape affects fish use, and how patterns of fish use relate to protection and restoration of these areas. This effort has been updated using DNA to include the San Juan Islands. In the Skagit intensively monitored watershed (IMW), spatial distribution is monitored in the nearshore and the estuaries using random sampling methods.

In 2006, 134 sub-yearling Chinook were acoustically tagged and released from Skagit Bay. Many of the tags were detected moving south and many tagged fish stayed in the area during the winter months. Some moved as far as Tacoma. Many of these tagged fish appear to be resident forms of Chinook (blackmouth).

Stillaguamish Nearshore Studies

The estuary was sampled for 4 years in the mid 2000's; however, currently the estuary is not being sampled.

Migration timing, distribution, habitat use, and relative abundance of juvenile salmonids through the estuary have been determined through beach seining by the Northwest Fisheries Science Center (NWFSC) and Tulalip Tribes from 2001-2010. Beauchamp and Duffy (2011) recorded that 0+ Chinook densities ranged from 1 to 13 per tow (within approximately 100 meters of the shoreline). A systematic sampling design throughout the entire estuary zone, and stratified by channel type and vegetation zone, has been used. Sampling has been performed either biweekly or monthly, primarily dependent on time and resources. Estuary-wide sampling is not being conducted in 2011 while data are analyzed and resources evaluated.

Snohomish River Nearshore

Conley (1977) used a beach seine to collect salmonids at the lower end of the Snohomish delta. Food studies and distribution of Chinook was described. Tulalip Tribe has conducted beach seining efforts since 2003 to examine the origins, distribution, spatial and temporal use, out-migration timing, relative abundances, timing and relative size upon entry to estuarine and nearshore marine habitats in Port Susan and Port Gardner. Limited nearshore marine beach seining and off-shore tow netting efforts were conducted in 2003 and 2004. Additional efforts for tow netting (Puget Sound-wide, including the Snohomish and Whidbey Basin areas) are underway in 2011, providing similar information (size, life history type, timing, distribution and relative abundance) on juvenile salmonid utilization of the nearshore marine habitats (Rice, et al. 2011). Tulalip Tribes conducted limited nearshore and lower estuary beach seining for 2 years in 1987-88. Coordination of sample sites and methods between studies has been consistent.

Densities of fish in terms of numbers per square meter are not calculated. Beach seining and fyke netting in the Snohomish estuary and nearshore marine habitats have been done since approximately 2001 by NOAA Fisheries and the Tulalip Tribes. While it is not clear how well the data can be used to calculate fry or parr densities, the nearshore marine and estuary juvenile seining and sampling efforts are providing important information on juvenile salmonid utilization of the Snohomish River estuary and nearshore marine habitats, co-occurrence, spatial and temporal use, out-migration timing, relative abundances, relative size (fork lengths, whole body weights, condition factors) as well as juvenile salmonid utilization of the Snohomish River estuary and nearshore marine habitats. The initial purposes of these studies were to determine if use of Snohomish River estuarine and nearshore marine habitats by juvenile Chinook salmon was correlated to life history type of the fish and attributes of the habitats (Rice, Duda, et al. 2012). Habitat use is defined by measuring growth rates, diet, distribution, abundance, and types of habitats used. Life history patterns are indicated by both timing and fish size at upon entry to estuarine and nearshore marine habitats, and by fish origin. Attributes of habitats include the geographic position of habitat in estuarine and nearshore marine habitats, salinity, depth, and water velocity. Information is being gathered and analyzed in these monitoring and research studies on fish origins, timing, and size of out-migrating/co-occurring juvenile Chinook, and type of sub-habitats

utilized. Collections of scales and otoliths for age/origin determinations and comparisons with future samples of scales and otoliths from adult returns also occur.

Central-South Sound MPG

Green-Duwamish Nearshore

From 2001-2005 several studies looked at fry and parr densities in Elliott Bay and lower Duwamish by King County, Taylor and Assoc., NOAA and the University of Washington. (Meyer, Pearce and Patlan 1980) sampled the Duwamish estuary with beach seine and purse seine. They reported that Chinook increased from late April with the peak in early May and then were at low numbers by the middle of June. Chinook were collected in both nearshore and offshore waters. (Parametrix, Inc. 1984) used 8 beach seine sites and 9 purse seine sites to sample areas of the Port of Seattle and Elliot Bay. They found only a few Chinook through the middle of May. In late May and June Chinook were found in moderate numbers at the Duwamish stations. Only in the middle part of June were many Chinook captured at the Elliot Bay stations.

Puyallup River

(Meyer, Pearce and Boomer 1981) studied food habits of Chinook at Hylebos Waterway and Commencement Bay using a beach seine and found Chinook present from the middle of May through June in the waterway and late May into August for Commencement Bay. (Miyamoto, Deming and Thayer 1980) collected Chinook at 50 sites within Commencement Bay using beach seines and round haul seines. They found juvenile Chinook beginning in late April with peak abundance in late May-early June, with substantial numbers into July. No Chinook were collected after July.

USFWS surveyed the Nisqually delta and found some Puyallup and Green River fish in the lower Sound.

Nisqually River

Fresh et al. (1978) sampled the edge of the Nisqually delta and adjacent shoreline using beach seine and a tow net in 1977-1978. They documented presence of Chinook from late May until late July. They also documented food consumed during that time. Pearce et al. (1982) used beach seines, fyke nets, and purse seines to sample the Nisqually estuary from 1979 until 1980. Chinook fry first appeared in the middle of May and were present into August. Chinook varied in size from 75-90 mm. No distinctions were made between hatchery and naturally reared Chinook. (Ellings and Hodgson 2007)

Beach seining was conducted 2002-present except for 2009 and lampara netting was conducted 2010 – present within the Nisqually tidal delta and adjacent nearshore. Fyke net trapping was also conducted in 2003. Densities were measured in terms of average catch per set by month at non-random habitat zones. Approximately 2-5 sites were examined 2 times per month between February and October. Nearshore fish sampling was conducted in the Nisqually Reach area of South Puget. Results indicate that significant numbers of juvenile salmon from Central and South Sound hatcheries, including the Puyallup and White River, use the Nisqually Delta and nearshore for rearing. Hatchery juveniles from throughout the Central and South Sound use habitat in the South Sound (Steltzner 2011). In addition, a

substantial number of marked fish came from the Puyallup and White River hatcheries. How this relates to wild fish behavior is not clear.

Freshwater Spatial Distribution

Freshwater spatial distribution is almost universally dependent upon adult spawner surveys for mapping distribution. In some cases juvenile density or distribution studies also contribute to the knowledge of the watershed. Juvenile migrant traps also provide some information on the timing and distribution of migrants. No probabilistic sampling of adults or juveniles is being conducted in Puget Sound at this time so there are not confidence limits or evaluations of the error in changes in distribution. The Salmon and Steelhead Habitat Inventory and Assessment Program (SSHIAP) is periodically updated and is currently transitioning to the National Hydrologic Data layer (NHD) system. Field biologists provide input periodically but a concerted effort to update the database based on measured changes in spawning distribution or juvenile distribution is not being specifically completed nor is there a clear update based upon barrier removal projects that provide access to previously blocked areas now considered anadromous habitat. Funding is needed to bring this database up to date and to be able to demonstrate changes in distribution and extension of the range of salmon and steelhead in Puget Sound. Adequate spatial information is critical for evaluating improvements in habitat conditions for Chinook. Anlauf (Anlauf, Jones and Stein 2009) describes the coho rearing habitat along the Oregon Coast as it is related to coho distribution. This was strongly considered in the recent review of Oregon coastal coho status.

Chinook Diversity Monitoring

Morphological and life history diversity of Puget Sound Chinook are universally dependent upon sampling adult carcasses from the spawning grounds and also collection of information from live fish captured for broodstock programs. Juvenile morphological information is obtained from periodic in-stream juvenile sampling and from information collected from downstream migrants obtained in screw traps, and other trapping methods.

A concerted effort has been underway to collect a baseline of the genetic DNA diversity within every TRT population. This has been accomplished for most populations of Chinook and is in part a contribution to the PSC evaluation of GSI as a tool for determining stock contributions in the fisheries coastwide. Also, a few areas have begun full parental genotyping as part of an evaluation of hatchery supplementation programs and their effects on natural population diversity. In some cases there are backlogs of samples that should be processed. In other locations GMR experiments are proposed for funding

SUMMER CHUM VSP ASSESSMENT

Hood Canal/Strait of Juan de Fuca summer chum ESU was listed as Threatened under the ESA in 1999. A Summer Chum Salmon Conservation Initiative (SCSCI) was completed in 2000. A comprehensive plan was developed for implementation of summer chum salmon recovery developed by state and tribal co-managers. Implementation, monitoring and evaluation began in 1992 of 'early' harvest and hatchery strategies. Harvest and hatchery components were approved by NMFS under Limits 5 and 6 of the ESA 4(d) rule, in 2001 and 2002. Supplemental reports, progress reports, and a 5-year review have recently been completed.

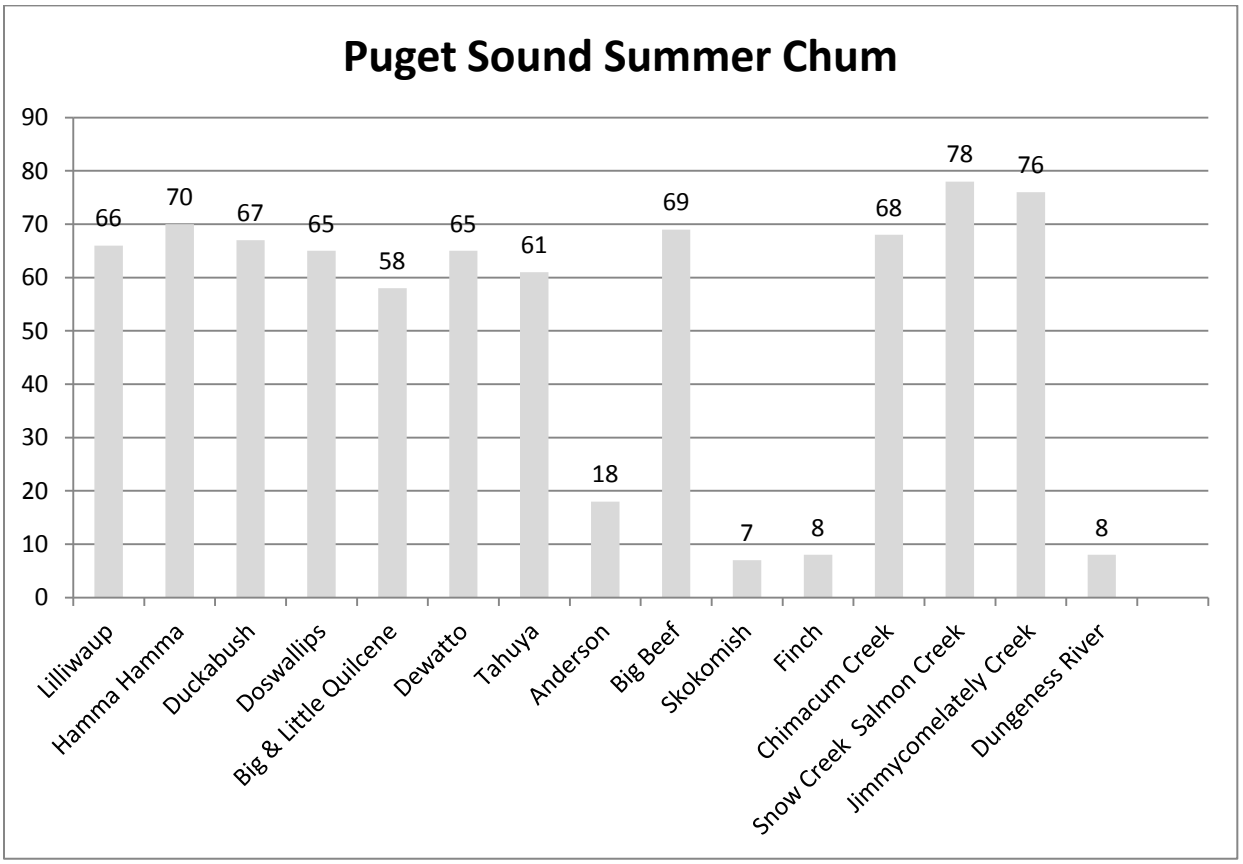


Figure 10. Hood Canal/Strait of Juan de Fuca summer chum VSP monitoring scores by population.

The Hood Canal Coordinating Council (HCCC) developed a summer chum recovery plan in 2005. HCCC is part of the watershed-based regional council of governments and lead entity for salmon recovery in Hood Canal. The HCCC Plan makes extensive use of the SCSCI and subsequent reports. SCSCI's harvest and hatchery provisions, interim recovery goals, were incorporated into the recovery plan. HCCC Plan addresses habitat protection and restoration and identifies and addresses Viable Salmonid Population (VSP) parameters.

Hood Canal/Strait of Juan de Fuca summer chum is overall being monitored well considering the number of small populations involved in the Hood Canal and Strait of Juan de Fuca regions. Continued DNA

analysis is needed to separate summer and fall chum in some streams. Also, continued monitoring of supplemented populations and reintroductions is needed.

Status of Adult Abundance Monitoring

Early chum spawn in August and September when rivers are at low flow and water conditions are ideal for counting salmon. Estimates are considered good. Some rivers utilize a counting fence or weir near the river mouth while others utilize redd counts or enumerate fish. Counting weirs are used on the Union River, Big Beef Creek, Finch Creek, Jimmycomelately Creek, Salmon Creek, and Snow Creek.

Counts of live and dead spawners are conducted in the Lilliwaup, Hamma Hamma, Duckabush, Dosewallips, Big and Little Quilcene, Dewatto, Anderson, Chimacum, and Tahuya, through the full extent of summer chum penetration. Counts of live and dead spawners at index sites are conducted on the Skokomish River. Counts are fitted to area under the curve (AUC) method to obtain total escapement estimate.

Spawner counts are usually conducted weekly from late August through October. The time from summer chum freshwater entry until dying is assumed to be 10 days.

Streams where early chum were extirpated and are now being introduced include: Big Beef Creek, Chimacum Creek, and Tahuya River.

Sources of Error include:

1. Unmarked hatchery fish are counted as wild fish.
2. Fish or redds are not visible due to water conditions or weather.

Status of Juvenile Out-Migrant Monitoring

Chum salmon spend very little time in freshwater and leave their natal stream within days of emergence from the gravel. Freshwater production estimates are being developed for Hamma Hamma and Duckabush rivers, and Salmon Creek. The Hamma Hamma trap was installed in 2002 and the Duckabush trap has been in place since 2008. Coefficient of Variation estimates for chum fry (composite summer and fall) annual abundance ranged between 4.6% and 20.0% for Hamma Hamma, and 4.8% to 6.3% for Duckabush since each trap has been in place. In 2011, DNA analysis of chum fry out-migrants was conducted on both the Hamma Hamma and the Duckabush rivers to determine proportions of early chum and late chum. Continuation of this study design will require continued funding. The Salmon Creek inclined plane trap has been operated since 2008 at RM 0.1, and throughout the entire outmigration period, Feb. through May. Salmon Creek chum 2008-2010 out migrant estimates have a CV value of ±4.96%. Overall monitoring is good and data quality is good.

Adult Productivity Calculations

Productivity information is collected from the spawner abundance efforts and from the carcasses examined during spawning surveys coupled with information from fish collected for broodstock at Union Bay and Hamma Hamma River traps. PHOS is determined from carcasses. Carcasses are sampled annually for otolith analyses by the WDFW Otolith Lab. All hatchery released fish are otolith marked. Scales sampled annually from carcasses on spawning grounds, and age composition is used to assign spawners to cohorts; done by WDFW for co-managers. Marine survival estimates are not available for naturally reared chum, but is done for supplementation program and used as surrogate for natural survival based on number of fry released and cohort reconstruction of returning adults.

Harvest Monitoring

Harvest of summer chum is reported on commercial fish tickets. The total harvest is apportioned to each stock based on the location of the fishery and on the escapement of each summer chum stock. The impact to natural chum is estimated based upon the PHOS-PNOS estimates taken from the spawner surveys.

Hatchery Effectiveness Monitoring Programs

Beginning In 1992, hatchery supplementation programs using indigenous stocks were implemented to recover stocks at high risk of extinction or boost existing runs to reintroduce summer chum into streams where they were extirpated. Rigorous standards and guidelines developed in the SCSCI and the Recovery Plan were followed. Supplementation programs were implemented in 1992 on Salmon Creek, Big Quilcene River, and Lilliwaup Creek in 1992; on Chimacum and Big Beef Creek in 1996; on Hamma Hamma River in 1997; on Jimmycomelately Creek in 1999; on Union River in 2000; and on Tahuya River in 2003. All programs except those on Lilliwaup and Tahuya have been discontinued per the Recovery Plan guidelines. The supplemented fish are all otolith marked so the determination of NOS and HOS is possible.

This program appears to be successful in reintroducing summer chum into areas where they were extirpated.

NMFS completed a study using supplementation-origin and natural-origin Quilcene summer chum in artificial spawning channels at the University of Washington Big Beef Creek research station. The results provide a measure of the relative reproductive success of SOR and NOR summer chum (Berejikian, VanDoornik, et al. 2009).

Status of Nearshore and Marine Monitoring

Very little specific information is available for the distribution and densities of summer chum in the nearshore and offshore areas versus the fall chum. (Bollens, et al. 2010), and other earlier workers have described the timing and food habitats of chum in the nearshore area, but none are able to separate

summer chum from fall chum. Adult return timing is known and entrance into the stream based on weir counts of summer chum.

Freshwater Spatial Distribution Monitoring

Freshwater spatial distribution is determined based upon spawning surveys and the distribution of redds and carcasses. Since chum spawn in the lower reaches of streams, these counts are considered accurate.

Chum Diversity Monitoring

Run timing and spawn timing determined from spawner surveys, fork length measured for carcasses by sex on the spawning grounds. DNA baseline is available for all existing populations. DNA samples are taken annually from the run.

STEELHEAD VSP ASSESSMENT

Steelhead population monitoring is dramatically deficient with all but six populations having an overall score of 40 or less points out of 120 possible points. The only exceptions were Snow Creek in Discovery Bay where a steelhead weir has been present since 1977 to count adults and juveniles and to obtain other life history information. The other exceptions were Skagit, Sauk, Green, Puyallup, and White which had only a modest score of 45-61.

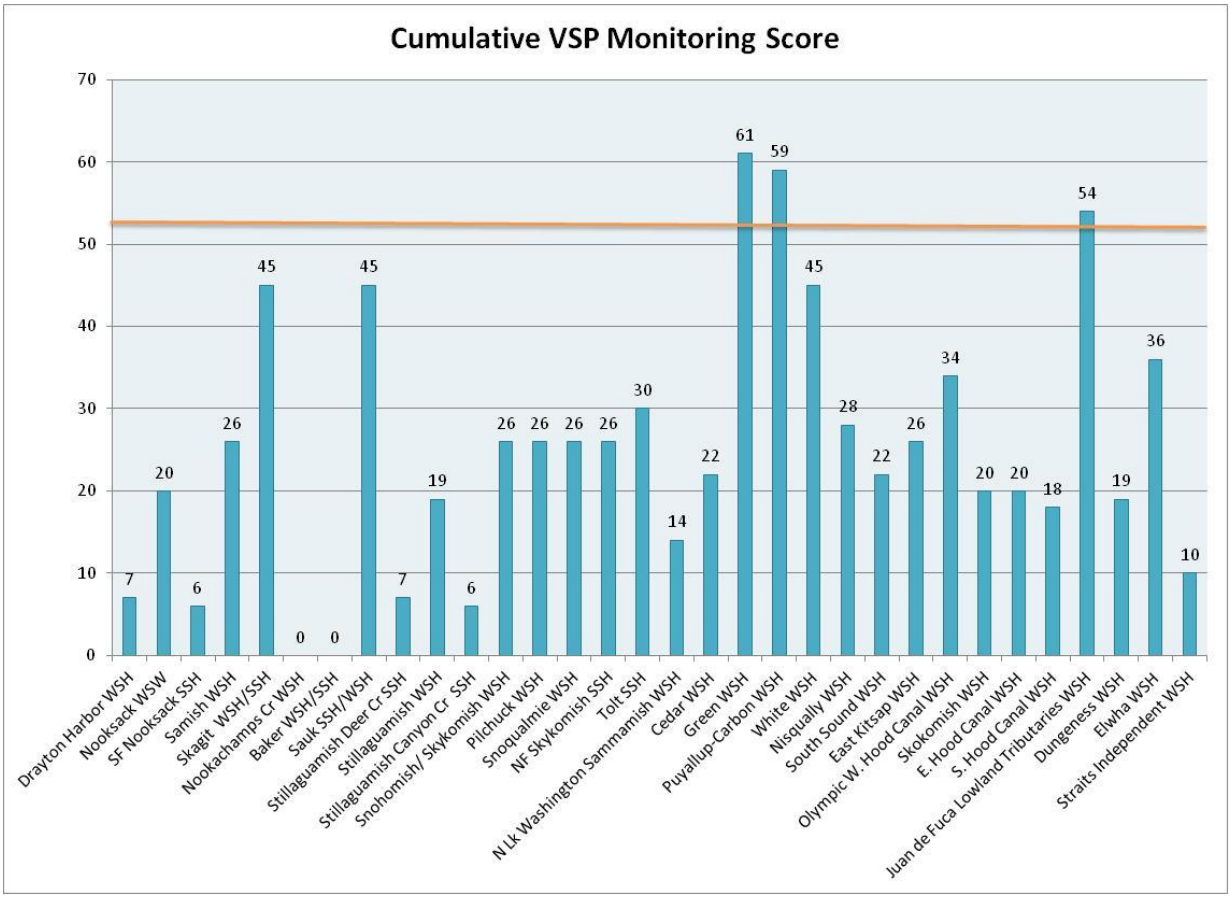


Figure 11. Puget Sound steelhead VSP monitoring score by population where scores above 70 are considered good 69-50 fair and 49 and below inadequate.

Washington steelhead juvenile migrants (smolts) are known from acoustic tagging studies (Fresh, et al. 1978) to migrate quickly individually or in small groups, through the estuary and into the open sea. Unlike Chinook, migration time is a matter of days with no long term feeding and growth period in nearshore estuary areas of Puget Sound. Once at sea, tagging studies have shown that they follow the California current north to Alaska and some penetrate as far westward as the Aleutian Islands before returning to Washington to spawn in their natal streams. Columbia River Washington tagged summer steelhead have been recovered as far away as the coast of Japan. Unlike, Pacific salmon species, steelhead trout demonstrate iteroparity and do not die after spawning, but can begin actively feeding

and regain condition. These fish are called kelts and move back downstream to the sea where they actively feed and grow and return again to spawn if they survive predators, fishers, and other obstacles. Most of the re-spawners are female because males prolong their stay on the spawning grounds until the majority of females have spawned and males are so physically depleted that few survive to regain condition. Some females have been documented by scale and otolith analysis to have returned to spawn as many as four or five times.

An additional complication in steelhead abundance and life history is that the rainbow trout is the non-anadromous form of steelhead and can contribute to anadromous runs. Rainbow trout can live and flourish in the same waters as the anadromous form. Also, male steelhead offspring may reach sexual maturity in freshwater early in life. Observations suggest that males showing precocious maturation may be at least in their second year due to size (McMillan, Katz and Pess 2007), although younger maturity could occur based on the fact that steelhead reared in hatcheries often become mature after a year of accelerated rearing (Viola and Schuck 1995) (Sharpe, et al. 2007)). It is unknown if precocious males migrate to sea after spawning. These mature young males are essentially a resident life-history form, similar to fish recognized as rainbow trout by other freshwater age and maturity characteristics. Several DNA pedigree-based studies (Ardren 2003); (Blouin 2003); (Seamons, Bentzen and Quinn 2004); (Kuligowski, Ford and Berejikian 2005); and (Christie, Marine and Blouin 2011) have shown or implicated non-anadromous males, such as precocious male steelhead offspring, as contributors to steelhead productivity. Thus, monitoring of resident *O. mykiss* associated with anadromous populations should be considered.

Status of Adult Abundance Monitoring

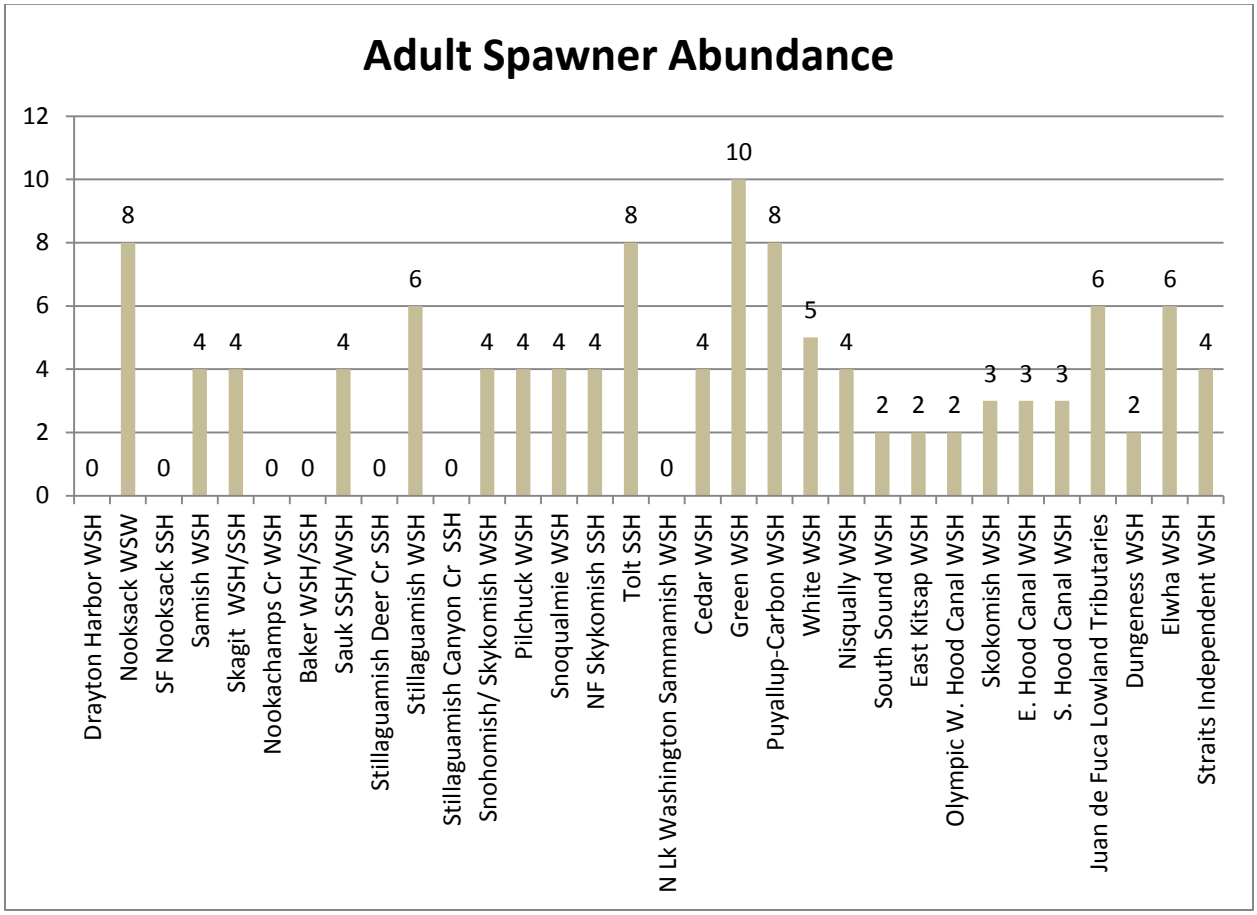


Figure 12. Steelhead adult abundance monitoring score by population.

Winter Steelhead

The VSP monitoring assessment for steelhead showed a poor ability to determine overall adult steelhead abundance. Only one population was given a perfect score for adult abundance monitoring and this was provided based upon tentative information. The following are the spawner abundance monitoring programs for winter steelhead populations.

Table 10. Winter steelhead adult abundance monitoring calculations and procedures.

TRT Population	Adult Abundance Method	Is CV value <16%	Fish per Redd	Survey Frequency	PNOS Estimated?
Olympic MPG					
West Hood Canal	AUC Redd Index Counts Hamma Hamma, Duckabush & Dosewallips No escapement objectives have been agreed to between WDFW and the Tribe	Not estimated	0.81 females and 1 male:female per redd.	7-10 days	Yes: Hamma Hamma supplementation 1998-2007 Duckabush supplementation underway
East Hood Canal	Dewatto Index spawner counts. redd counts expanded to estimates of spawner escapement	Not estimated	0.81 females and 1 male:female per redd.	7-10 days	Yes; Dewatto supplementation underway
South Hood Canal WSH	Union, Tahuya Index spawner counts. redd counts expanded to estimates of spawner escapement	Not estimated	0.81 females and 1 male:female per redd.	7-10 days	Yes
Skokomish WSH	The number of spawners is determined by total redd counts * in index sites No escapement objectives have been agreed to between WDFW and the Tribe	Not estimated	0.81 females and 1 male:female per redd.	7-10 days	Yes; South Fork Skokomish supplementation underway
Elwha WSH	Since 2005 spawner surveys below dam	Not estimated	Not estimated		No
Dungeness WSH	Index escapements based on redd counts in index areas. Escapement estimates have not been made on an annual basis since 1995. The Dungeness River can be difficult to survey for steelhead because of high flows, especially in May. No established survey record due to turbidity and flow. Early surveys possible but spring melt ends opportunity. Not able at present to determine adult abundance for entire run.	Not estimated	Not estimated	Not estimated	Not estimated
Juan de Fuca Lowland WSH	Since 1977 Escapement estimates at Snow Creek fish facility and spawner surveys	Not estimated			
Straits Independent WSH	Some information from IMW streams	Not estimated	Not estimated	Not estimated	No
North Cascade MPG					
Drayton Harbor WSH	Not estimated	Not estimated	Not estimated	Not	Not estimated

TRT Population	Adult Abundance Method	Is CV value <16%	Fish per Redd	Survey Frequency	PNOS Estimated?
				estimated	
Nooksack WSH	Redd surveys at 7-10 day intervals of the heavily used tributaries and expansions to other tributaries from 2010 base year when all steelhead tributaries were surveyed. All expanded redd counts are assumed to have 1.62 fish per redd. The forks and mainstem surveys are by aerial flights, with expansions for non-surveyed periods (after snowmelt prevents counts), from side channel foot surveys which occur for the entire period."	Not estimated	1.62 fish per redd	7-10 days	Not estimated
Skagit River WSH/SSH	AUC calculated and divided by redd life for various reaches based on redd life scores for those reaches. 13 index reaches are surveyed for redds on tributaries. The rest of the basin is estimated by expanding the sampled tributaries	Not estimated	2 spawners per redd	7-10 days	Not estimated
Nookachamps Cr WSH	Not estimated	Not estimated	Not estimated	Not estimated	Not estimated
Baker WSH	Extinct	Extinct	Extinct	Extinct	Extinct
Sauk River WSH/SSH	AUC calculated and divided by redd life for various reaches based on redd life scores for those reaches.	Not estimated	2 spawners per redd	7-10 days	Not estimated
Samish WSH	Based on cumulative redd counts in index section in the main stem Samish and in Friday Creek	Not estimated	Not estimated. Assumed to be 1.62 fish/redd	7-10 days	Not estimated. since Samish is now a wild steelhead management zone, PNOS assumed 100%
Stillaguamish WSH	Marked redd census in index reaches	Not estimated	Not estimated	7-10 days	Not estimated
Snohomish/Skykomish WSH	Foot and float redd counts in main stem and tributaries when visible	Not estimated	Not estimated	7-10 days	Not estimated
Pilchuck WSH	Marked redd census in index reaches	Not estimated	0.81 females per redd.	7-10 days	Not estimated
Snoqualmie WSH	Ground based marked redd census in index reaches	Not estimated	0.81 females per redd.	7-10 days	Not estimated

TRT Population	Adult Abundance Method	Is CV value <16%	Fish per Redd	Survey Frequency	PNOS Estimated?
Central-South Sound MPG					
North Lake Washington – Sammamish WSH	River. No surveys of Sammamish River or tributaries.	Not estimated	Not estimated	Not estimated	Not estimated
Cedar River WSH	Redd surveys of the Cedar	Not estimated	1.86 fish/redd	7-10 days March-June	Not estimated
Green River WSH	redd-based escapement is estimated on main stem and major tributaries. Considered a census	Not estimated	1.86 fish/redd	7-10 days	Not estimated
Puyallup/Carbon WSH	Both float and aerial surveys are conducted in the main river when visibility allows.	Not estimated	1.62 males per female	7-10 days March-June	Not estimated
White River WSH	Foot and Float surveys of most tributaries and occasionally in mainstem below Buckley. Considered an index estimate of probably 90% 0f the spawning area.	Not estimated	1.62 males per female	7-10 days March-June	Not estimated
Nisqually WSH	Helicopter flights are used to count steelhead redds in the main river. Need to beef up spawner surveys and settle on what tributaries should be included in the overall estimate or kept separate.	Not estimated	Not estimated	Not estimated	Not estimated
South Sound WSH	Index area and supplemental surveys Kennedy, Skookum, Sneider creeks	Not estimated	Not estimated	Not estimated	Not estimated
East Kitsap WSH	Spawner surveys conducted sporadically since 2002 in Chico Creek and Blackjack and Curley Creeks.	Not estimated	Not estimated	Not estimated	Not estimated

Summer Steelhead Populations

There are five identified summer steelhead populations in Puget Sound: South Fork Nooksack River, Deer Creek, Canyon Creek, Tolt River, and North Fork Skykomish River. Two of the summer steelhead populations in Puget Sound have estimates of adult abundance; little can be said of the status or trends of the others. Since these populations appear to be genetically unique from the winter runs there is a need to monitor sufficiently at least one or two of these populations. Those populations best monitored include North Fork Skykomish and Tolt Rivers.

Table 11. Summer steelhead adult abundance calculation procedures

TRT Population	Adult Abundance Method	Is CV value <16%	Fish per Redd	Survey Frequency	PNOS Estimated?
North Sound MPG					
SF Nooksack SSH	Not estimated	Not estimated	Not estimated	Not estimated	Not estimated
Deer Creek SSH	Washington Department of Game conducted snorkel counts of adult summer steelhead in the pools in Deer Creek and Squire Creek in the 1970s as a means of determining relative adult abundance.	Not estimated	Not estimated	Not estimated	No
Canyon Creek SSH	Not estimated	Not estimated	Not estimated	Not estimated	Not estimated
Tolt River SSH	A marked redd census of the entire spawning area is conducted in NF and SF Tolt. PIT tagging underway.	Not estimated	0.81 females per redd. 2 fish per redd	7-10 days	No
NF Skykomish SSH	There are only two years of data. Population was not monitored until 2010 when snow conditions allowed vehicle access.	Not estimated	Not estimated	7-10 days	No

Status of Juvenile Migrant Monitoring

Twenty three steelhead populations lack estimates of juvenile migrants. At those locations there is no capability to determine freshwater production status and trends. For another three populations (Lake Washington, South Sound, and Skokomish) information is obtained for only part of the population or the trap data cannot be calibrated. The Green, Puyallup, Nisqually, and Dungeness Rivers, and Snow Creek have calibrated migrant estimates over the full migrant time period. Tahuya smolt abundance estimates represent a portion of total South Hood Canal population smolt abundance. Dewatto and Big Beef creeks smolt abundance estimates represent a portion of total East Hood Canal population abundance. Little Quilcene and Duckabush smolt abundance estimates represent a portion of the West Hood Canal population.

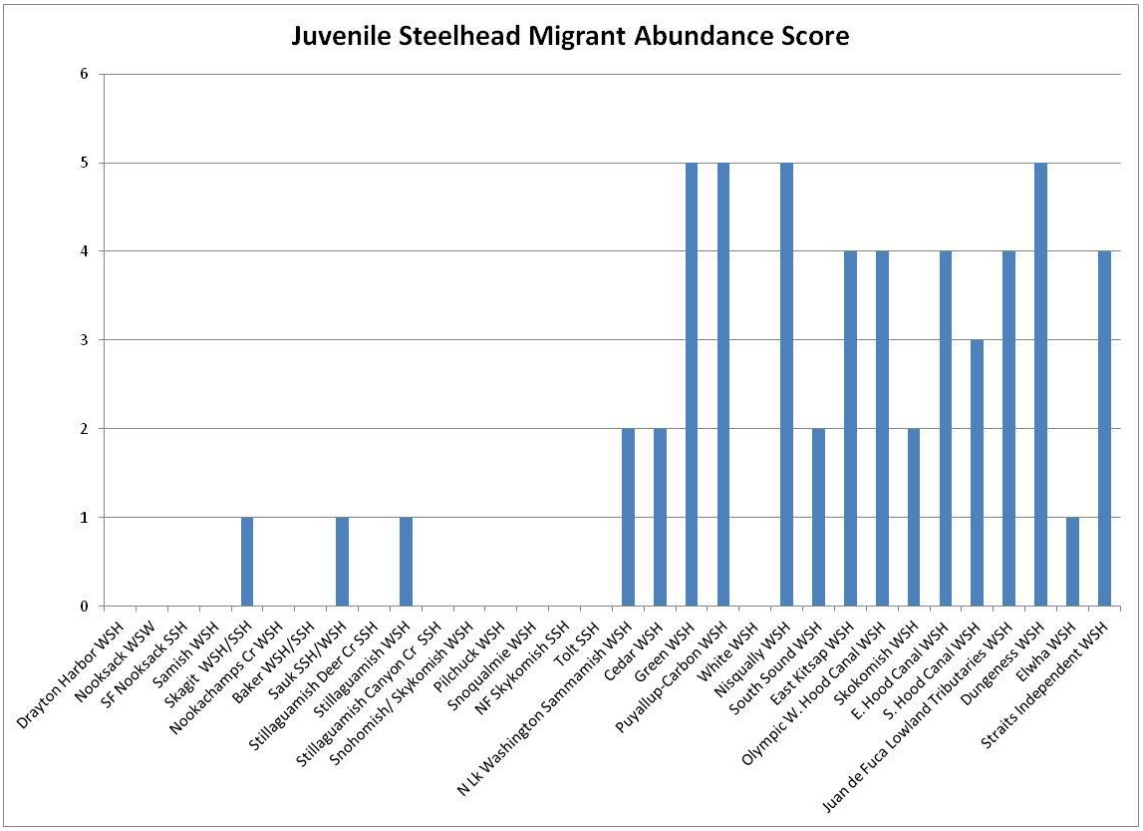


Figure 13. Juvenile migrant steelhead monitoring scores by population.

Status of Adult Productivity Estimates

Adult productivity estimates are very difficult to calculate at this time due to lack of access to natural steelhead adults. Age structure, marine survival estimates and freshwater survival estimates are only available at a few locations where fish in and fish out information are sufficiently accurate to have some confidence in the data. Those locations include the Hamma Hamma, Green, and Puyallup Rivers, and Snow Creek.

Status of Harvest Estimates

Puget Sound steelhead have been monitored for recreational harvest since the early 1940s using a punch card system that later became the present sport catch record card. These data from the return of catch cards from recreational fishers are expanded based on a double sampling system that estimates the percentage of cards returned and the success rate of those anglers who did not turn in their card. Adult abundance estimates using spawning surveys have been conducted on some streams on an annual basis since the 1970s. In many cases natural fish production was counted at weirs constructed to trap fish for early 1916-1930s hatchery egg takes; hydroelectric facilities; and fishways where wild fish could

be trapped (B. Crawford 1979). Steelhead were designated as a gamefish early in the state's history (1925) and were not legally commercially harvested from 1933 until the US v Washington federal court proceedings provided up to 50% of the harvestable steelhead for tribal fisheries. Prior to that time the philosophy of managers was that sport fisheries were not efficient enough to over harvest wild stocks as long as sufficient closed areas in the upper portions of major steelhead streams were available as refugia. Whether this philosophy was accurate is debatable. Few historical counts of tribal harvest are available in Puget Sound.

Currently there are no ocean fisheries targeting steelhead coastwide. All fisheries are terminal or Puget Sound pre-terminal sport fisheries using mark release regulations to target hatchery fish, or commercial or tribal net fisheries targeting other more abundant salmonids such as sockeye, fall chum or pink salmon. Commercial and tribal mortalities are reported through commercial trip tickets. Sport catch incidental take of steelhead are estimated from wild release compliance statistics and delayed mortality estimates. There is no retention of Puget Sound wild winter steelhead in sport river fisheries. A 10% hooking mortality is calculated with a wild fish encounter rate of 0.086 for fisheries ending February 1 and 0.122 for a fisheries ending February 15th. This is due to the shifting dominance to wild populations and fewer hatchery fish after February 1. Because these fisheries are so restrictive and incidental take is small, the ability to sample VSP characteristics such as size, age, sex, timing, and others is extremely limited.

Steelhead Hatchery Effectiveness Monitoring

Fisheries managers have been trying to raise hatchery steelhead since the 1890s as part of perceived needs to enhance wild populations so that harvest and recreation opportunities could be maintained enhanced or spread to other areas. Early efforts took eggs from wild steelhead and hatched them in a hatchery where they were raised until the egg sack was absorbed and then released into selected streams. These early attempts did little to enhance stocks beyond stream carrying capacity because the hatchery releases were subject to the same survival Impacts of stream hatched wild fish for most of two years before migrating to the sea. It was not until the work of Clarence Pautske and Robert Meigs that techniques were developed to raise steelhead to smolt size in one year thus bypassing the limiting habitat constraints of the freshwater portion of their life cycle (Pautske and Meigs 1940). The first smolts were produced at Chambers Creek Hatchery where spring water temperatures coupled with early egg takes and photo manipulation allowed an extended growth period capable of producing smolts in one year. These fish became the prototype for hatchery stocking in most of the winter steelhead streams in Puget Sound. Since these fish were selectively bred for early spawn timing and migration their overlap with wild populations was assumed to be minimal. However, some introgression of hatchery genes into the wild populations has undoubtedly occurred and has been documented in some populations. The extent and degree of damage this may have occurred is still open to debate by managers. A current study in the Skagit Basin, funded by a Saltonstall-Kennedy Fund grant, is investigating this issue.

However, hatchery programs today for steelhead have been reduced, eliminated or modified in many rivers to respond to the possible threats of genetic introgression and ecological impacts upon

productivity and survival. Most of the programs eliminated or reduced were derived from the original Chambers Creek winter steelhead hatchery stock or the Skamania (Columbia Basin) summer steelhead hatchery stock. Since 2006, the hatchery program in Puget Sound has been reduced by 50%. Hatchery programs eliminated or reduced are shown in Table 8.

Table 12. Washington Department of Fish and Wildlife steelhead hatchery programs eliminated or reduced in Puget Sound since 2006.

Hatchery Program	River	Numbers Eliminated or Reduced	Current Wild Population Status
Olympic Peninsula Steelhead MPG			
Eells Springs WSH	Skokomish	No current program	
Dungeness Hatchery WSH	Dungeness	6,000 reduced	
Elwha Hatchery WSH	Elwha	35,000 discontinued	To be Re introduced to former range
North Cascades Steelhead MPG			
Marblemount WSH	Sauk	30,000 discontinued	
Whatcom WSH	Samish	40,000 discontinued	
Barnaby Slough WSH	Skagit	200,000 closed	
Whitehorse SSH	Canyon Creek	5,000 discontinued	Unknown
Whitehorse SSH	SF Stillaguamish	15,000 discontinued	Unknown
Whitehorse WSH	Pilchuck Creek	10,000 discontinued	
Reiter Pond WSH	Pilchuck	30,000 discontinued	
Reiter Pond WSH	NF Skykomish	11,000 discontinued	
Reiter Pond SSH	NF Skykomish	13,000 discontinued	
Reiter Pond SSH	Raging	27,000 discontinued	Not historically present
Tokul Creek WSH	Raging	20,000 discontinued	
Reiter Pond SSH	Snoqualmie	50,000 discontinued	Not historically present
Reiter Pond SSH	Sultan	25,000 discontinued	Not historically present
Tokul Creek WSH	Tolt	25,000 discontinued	
Central-South Sound Steelhead MPG			
Palmer Hatchery SSH	Green	50,000 closed	
Palmer Hatchery WSH	Green	175,000 closed	
Puyallup Hatchery WSH	Puyallup	34,000 discontinued	
Puyallup Hatchery WSH	Deschutes	Discontinued	Not historically present
Voights Cr Hatchery WSH	Carbon	200,000 discontinued	

Remaining steelhead programs are a mixture of early segregated stocks and natural stocks developed from and replenished by wild steelhead adults from the watershed where they are released. Those programs are intended for harvest and managed as such. The second group of steelhead hatchery programs are designed to act as a "safety net" by supplementing natural populations in the hatchery until productivity is improved and they are self-sufficient. At present there does not appear to be for Puget Sound a strategy similar to that developed for the Columbia River (Galbreath, et al. October 2008) that focuses on where monitoring for hatchery effectiveness should occur.

The following current hatchery programs were identified as having a potential impact on VSP monitoring results. The impacts can range from inaccurate spawner information if adult hatchery fish are not easily identified in the escapement to errors in freshwater production if supplemented juvenile production

cannot be identified at migrant traps so that the true basin natural production capabilities are able to be calculated. Also, reproductive fitness directly affects productivity and despite adequate spawner escapements can depress productivity.

Hatchery Segregated Harvest Programs

Kendall Creek Hatchery (WDFW)

This hatchery releases segregated Kendall stock/Chambers origin winter smolts into Kendall Creek, and Whatcom Creek, Nooksack River. Concern has been expressed whether these adult fish intended for harvest remain temporally segregated from the native winter steelhead population(s) in natural spawning areas or compete and interbreed with natural spawners? No effectiveness monitoring at this time. This program has struggled to obtain enough brood stock to support the program.

Marblemount Hatchery (WDFW)

Marblemount releases segregated Skagit winter run smolts into Clark Creek, tributary to the Skagit and others go to Baker River for release at the Baker trap into the Skagit. No supplementation program has been implemented. Currently there is a genetic study underway basin-wide to evaluate impacts from this segregated stock on genetic diversity, to detect introgression within wild spawning sub-populations, and to measure natural production by hatchery fish spawning together.. The study began in 2009 and the results are due in 2012.

Samish Hatchery (WDFW)

Hatchery segregated stock fish plants were discontinued in the Samish River due to steelhead management plan concerns for the impact of Chambers Creek segregated stock coming from Kendall Creek hatchery upon the wild population. Baseline DNA work indicated that there was Chambers Creek origin influence in wild born fish. The Samish wild population provides an opportunity to verify whether removing direct hatchery effects on natural stocks will cause improvements in overall survival and performance. No monitoring is funded at present to follow any changes in reproductive fitness (due to reduced interbreeding) or increased productivity (due to removal of competitive effects).

Tokul Creek Hatchery

Tokul Creek hatchery releases segregated winter steelhead into the Snoqualmie River. Co-managers would like to develop a phenotypic and genetic monitoring and sampling plan and develop methods to collect origin, age, length and sex ratio data. There is a funding proposal to study the effects of this population at proposal #176.

Whitehorse and Reiter Rearing Ponds (WDFW)

Whitehorse releases Skykomish segregated summer steelhead smolts into the NF Stillaguamish River. It also releases into NF Stillaguamish River Stillaguamish winter steelhead segregated stock smolts. Whitehorse Pond and Reiter Pond Skamania summer steelhead have been identified as having possible genetic introgression effects on co-occurring native Deer Creek and Canyon Creek summer steelhead populations. Competition from wild-born offspring of Skamania stock steelhead may also affect

productivity of wild populations. This type of negative effect was demonstrated for Clackamas (Oregon) steelhead (Kostow, Marshall and Phelps 2003); (Kostow and Zhou 2006). No monitoring at present is addressing concerns that segregated hatchery stocks are interbreeding with the native winter steelhead populations in natural spawning areas and are not segregated spatially, or are creating ecological impacts. There is a proposal to develop a summer steelhead wild stock hatchery program with Deer Creek summer runs for integration or supplementation. A monitoring program should be established with a BA design for this program if implemented.

Soos Creek Hatchery (WDFW)

Soos Creek Hatchery ships to Icy Creek Hatchery Green River segregated (Skamania Stock) summer steelhead fingerlings. It releases Green River segregated summer steelhead stock smolts into Soos Creek. It ships to Icy Creek Hatchery Green River segregated winter steelhead stock fingerlings, and it ships to Flaming Geyser Pond Green River segregated winter steelhead stock fingerlings. It releases Green River segregated winter steelhead stock smolts. It also releases into Soos Creek integrated late winter wild Green river steelhead smolts. 20 females and 20 males are caught by hook and line from the main Green River for the wild integrated late program. In the future redd pumping may be used. This harvest augmentation program may provide a platform for changing to an integrated hatchery stock for the Green River and should be funded for more careful monitoring using a valid before and after monitoring design. Funding Proposal #181 addresses this gap by monitoring the segregated hatchery programs' effects on wild population attributes restricted to measuring pHOS.

Hatchery Integrated Conservation (Safety Net Programs)

Hood Canal Supplementation Program

The release of hatchery-reared steelhead smolts, for harvest purposes, has been discontinued in Hood Canal with the last hatchery summer-run smolts released in 1981 and the last early-timed Chambers Creek stock winter-run hatchery smolts released in 2004. A supplementation program using indigenous stocks was implemented on the Hamma Hamma River during 1998 through 2007.

To aid in the recovery of self-sustainable winter steelhead populations in three Hood Canal streams (namely, the South Fork Skokomish, Duckabush, and Dewatto rivers), a new integrated conservation (supplementation) program, using indigenous stocks, was implemented beginning with brood year 2007. The Hood Canal Steelhead Project (Berejikian, Hood Canal Steelhead Supplementation Project Draft Study Plan 2007) is a collaborative effort between National Marine Fisheries Service (NMFS), Washington Department of Fish and Wildlife, Skokomish Tribe, the Port Gamble S'Klallam Tribe, the Point No Point Treaty Council (representing the Jamestown S'Klallam Tribe and Port Gamble S'Klallam Tribe), Long Live the Kings, and the Hood Canal Salmon Enhancement Group. A Hatchery Genetic Management Plan (HGMP) for the supplementation program has been prepared and submitted to NMFS for review; the HGMP includes a copy of the full supplementation study plan. A longer-term goal of the project is to provide a harvestable surplus of returning winter steelhead adults to support Treaty and Non-Treaty fisheries.

As part of the Hood Canal winter steelhead conservation hatchery programs, approximately 42,000 two-year old steelhead smolts will be released annually into three Hood Canal streams beginning in 2009. In addition, the programs call for approximately 800 four-year old steelhead adults to be released every other year beginning in 2011. The program is planned to end with eyed egg collections from brood year 2014 and the subsequent releases of smolts in 2016 and adults in 2018; research and monitoring is planned to continue through 2022. See proposal #142.

Lower Elwha Hatchery (S'Klallam Tribe)

A captive brood program has been established to supplement Elwha restoration for fry production and also for possible release of up to 100 reconditioned kelts. 160,000 progeny of the captive brood program are to be released with blank CWT and no AD clips and are designated as Late winter Elwha steelhead. This program is part of the HGMP for the Elwha Hatchery to change to a native stock for hatchery brood stock source. This is a ten year program (2022) to evaluate results. All captive brood are being evaluated for DNA and mating. They intend to equip all late run supplemented fish with location specific tags that will allow for options for monitoring success of distribution and release locations. However, procedures are not formalized at this time. See funding proposal #158

Puyallup DIRU hatchery (Puyallup Tribe)

Since 2006, in partnership with Puyallup Tribe, Muckleshoot Tribe, and WDFW have raised 30,000-50,000 White River steelhead for release back into White River as part of a pilot program to improve winter steelhead escapements into the White River. Broodstock are unmarked natural White River Steelhead. The goal is to develop a natural White River stock from captured wild steelhead in the White River. Hatchery effectiveness evaluation is ongoing each year. Status of this pilot will influence whether additional supplementation fish are used in the Puyallup River.

Status of Nearshore and Marine Monitoring

Steelhead are seldom caught or encountered while using tow nets and beach seines that are adequate and appropriate for Chinook and other smaller salmon juveniles who follow the shorelines in Puget Sound. Steelhead move away from nearshore areas rapidly and move through the Sound. Acoustic tagging has provided some insight into their migration through the Pacific Ocean Shelf Tracking (POST) program. The baseline of survival detection rates calculated to date suggests different patterns and rates for different stocks, and differences between hatchery and wild fish.

Olympic Peninsula MPG

Some nearshore and offshore work has been done with steelhead using acoustic tags in Hood Canal by NOAA Fisheries, Port Gamble S'Klallam Tribe, Long Live The Kings, Hood Canal Salmon Enhancement Group and WDFW. Each year from 2006 through 2010 a limited number of out-migrating smolts were caught by the smolt traps and were implanted with an acoustic tag. Acoustic receivers were deployed at the mouth of each river, in Hood Canal, and through the Strait of Juan de Fuca. Data collected from the receivers has provided information on migratory behavior, habitat use, and survival of steelhead migrating to the Pacific Ocean.

In 2006-07, wild smolts from Big Beef Creek, Dewatto River, Skokomish River, Hamma Hamma River and Snow Creek were monitored. (Moore, Berejikian and Tezak 2010) estimated survival rates for wild and hatchery smolts from river mouths to the northern end of Hood Canal ranged from 67% to 85% in 2006 and from 64% to 84% in 2007. Migration from the north end of Hood Canal to the Strait of Juan de Fuca, estimated survival rates ranged from 23% to 49% in 2006. The one hatchery-reared population (Hamma Hamma) exhibited migration characteristics similar to wild populations, but survival rates were significantly lower from river mouth to the Strait of Juan de Fuca acoustic line. In 2006, travel rates through Hood Canal (8.0 km/day) were significantly lower than those observed in the Strait of Juan de Fuca (25.7 km/day). Residence time and migration patterns within Hood Canal were highly variable within and among populations.

Work done at Big Beef Creek (Moore, Goetz, et al. September 20, 2010) indicate the median estuarine time for steelhead was 1.1 hours and the residence time in Hood Canal is only 8 days. This paper did not estimate survival but only half of the acoustic tags detected at the Hood Canal Bridge were later detected at the Juan de Fuca acoustic line.

Central-South Sound MPG

In central Sound, a multi-year program was established to monitor hatchery and wild steelhead smolts migrating from large rivers in eastern Puget Sound through the estuary. They conducted an intensive study of 3 groups of steelhead in the Green River and provided a summary comparison with releases from three other rivers. They compared the relative survival, migratory behavior and habitat use between hatchery and wild upper Green River releases with middle Green River; and between the Green, Puyallup (Wild and Hatchery), Nisqually (Wild) and Skagit (Wild) Rivers. Steelhead smolts (200) were tagged In the Green River. Relative survival (detection rate) was fairly consistent for all release groups – within Green River detections were - 81% Upper Green, 86% Hatchery, and 88% Wild; in the Duwamish estuary 76% Upper Green, 78% Hatchery and 78% Wild; in the Elliot Bay to Admiralty Inlet area – 48% Upper Green, 46% Hatchery, and 54% Wild; Juan de Fuca Strait - 6% Upper Green, 4% Hatchery and 4% Wild. These data may indicate a huge drop in survival between the nearshore and the acoustic array in Juan de Fuca.

Nisqually River knowledge of distribution through Puget Sound was improved by tagging 50 migrant steelhead with acoustic tags each year and conducting acoustic surveys in 2006-7 and 2009 (Fresh, et al. 1978). They concluded that steelhead outmigration from the Nisqually estuary mostly occurs in May and early June. Most steelhead passed through the Nisqually estuary quickly (1-2 days) and migrated directly to the offshore areas. Some stayed in the estuary longer, and some headed back upstream once or repeatedly before migrating to Puget Sound.

The fate of steelhead passing through the marine waters of Puget Sound remains a critical uncertainty and is addressed in the Discussion portion of this report. A proposal for researching this critical uncertainty is described in proposal #128.

Status of Freshwater Distribution Monitoring

Freshwater spatial distribution by necessity has depended upon redd surveys since juveniles can be either the non-anadromous form of rainbow trout or steelhead but cannot readily be separated. It appears that their distribution is shrinking in South Sound and Kitsap peninsula. Also the Lake Washington – Cedar River drainage has declined to very low numbers of steelhead but Cedar River apparently supports high numbers of resident *O. mykiss* (WDFW, unpublished data). Distribution information will probably continue to be as good as the spawner survey methodology unless PIT tagging or genetic mark-recapture and parentage methods are used within the watersheds to parse out anadromous and resident percentages and distribution. There are a few proposals that will address spatial distribution and rainbow steelhead relationships. These include #151, #152, #155, and #186.

Diversity Monitoring

Diversity information on wild naturally produced steelhead is scarce and inconsistent across the Sound. A baseline of genetic information based on protein allozymes was developed (1970-1990) but has been replaced with microsatellite DNA and some SNP DNA data. The steelhead TRT did not have comprehensive genetic and life history data to use for determining the true extent of existing diversity among populations and major population groups due to the lack of genetic samples collected on steelhead populations, an out of data genetic baseline, and lack of funding to process existing genetic samples.

Olympic Peninsula MPG

As part of the Hood Canal Steelhead Project, studies have been initiated to collect and analyze genetic information to better understand genetic structure and diversity of Hood Canal steelhead. Preliminary DNA results for winter steelhead indicate there is a small distinction between steelhead in each river sampled. There appears to be a clustering of the West Hood Canal (Skokomish, Hamma Hamma, Duckabush, and Dosewallips and the East Hood Canal (Tahuya, Dewatto, and Big Beef Creek) aggregations of steelhead. The data suggests there is apparent genetic divergence between the natural winter steelhead stocks and the hatchery winter steelhead stocks (Bogachiel and Tokul Creek) which had been released as hatchery smolts in Hood Canal in the past. Samples from within a river system tend to cluster more closely with each other, regardless of life history type (e.g., parr, smolt) or location (upstream or downstream of anadromous barriers).

DNA baselines for Snow Creek are available from 2006 and 2007 smolt samples. No genetic information is available for Discovery Bay winter steelhead except Snow Creek. No genetic analysis has been performed for Sequim Bay winter steelhead. There is very little information about Dungeness River natural origin steelhead diversity other than the adult spawner timing at the front end of the run and out migration timing from juveniles at the trap. For the Elwha River, the co-managers have the Chambers Creek stock DNA profile and native late Elwha profile identified and also resident rainbow DNA with a lot of DNA variation observed in resident rainbow upstream of the dam sites among sampled locations. Genetic baselines were developed in 2001 with the most recent collections occurring in 2008. The co-managers are proposing to take DNA samples from weir captured steelhead in the future.

Northern Cascades MPG

No DNA information exists for the Drayton Harbor TRT population. Those fish are early spawning and ESA permits have not been coordinated adequately between NOAA Fisheries and the co-managers in a timely manner in the past for early spawning winter steelhead sampling. However, this has been rectified. Some DNA data are available for Nooksack winter steelhead, and South Fork Nooksack summer steelhead. DNA samples collected from incidentally caught fish in the fisheries have been evaluated. Few population baseline data are available but the co-managers are developing them. Allozyme analysis of South Fork Nooksack summer steelhead showed them to be very different from other Nooksack and north Puget Sound steelhead stocks (Phelps, et al. 1997). Baseline DNA samples were taken in 2008 and 2009 from Samish adult winter steelhead and have been analyzed for the TRT.

Allozyme analysis of Skagit winter steelhead sampled in 1994 clustered them with Sauk steelhead), Suiattle winter steelhead, North Fork Stillaguamish steelhead, and with steelhead from the Skokomish, Dosewallips, and Dungeness rivers (Phelps, et al. 1997). DNA sampling has been performed recently in many Skagit Basin locations and over several years (approx. 1,400 fish), and preliminary data analyses have been completed. A report is due in 2012. Preliminary results show the middle and upper Skagit River main stem and tributaries are of one Skagit River summer-winter population. There is a desire to perform DNA sampling and testing of the Lower Skagit River such as Nookachamps steelhead population.

Allozyme analysis of Stillaguamish winter steelhead collected in 1993 clustered them with Sauk winter and summer steelhead, Suiattle winter steelhead and with winter steelhead in the Skokomish, Dosewallips and Dungeness rivers (Phelps, et al. 1997). Genetic data for a 2006 smolt sample are available, but do not provide information on differentiation between North Fork and South Fork Stillaguamish spawning aggregations. DNA microsatellite data for Deer Creek summer steelhead (1995 sample) recently have been collected.

No genetic analysis has been completed on Canyon Creek summer steelhead. It is possibly a mixed stock of native and introduced (out of DPS) Skamania stock origin. There are no adequate DNA data for Pilchuck and Snoqualmie rivers winter steelhead or for native Skykomish summer steelhead.

WDFW Genetics Lab staff (Todd Kassler) in collaboration with Seattle City Light (Liz Ablow) conducted a genetic analysis of 75 juvenile steelhead (three size classes) obtained from the South Fork Tolt River upstream of the South Fork Tolt canyon. Fifteen microsatellite markers were screened and preliminary results comparing SF Tolt, hatchery stocks and other Puget Sound steelhead are available. This South Fork Tolt DNA project report is pending.

Central-South Sound MPG

Baseline information for Lake Washington steelhead was developed from samples collected in the 1970s using scales as the DNA source. Genetic analyses were conducted on juvenile *O. mykiss* sampled in 1993 and 1994 in the main stem Cedar River below Landsburg Dam, which were assumed to originate from steelhead parents (Phelps, et al. 1997). (Marshall, Small and Foley 2006) collected DNA data for steelhead sampled at Ballard Locks from 1997 to 1999 and in 2003, and used these data for comparisons

with Cedar Basin resident *O. mykiss* and a few other steelhead populations. Currently so few steelhead are present that DNA samples are difficult to obtain.

A baseline of DNA information was developed in early 2000 from wild Puyallup River steelhead. The co-managers intend to have a continual collection of DNA samples and archives of samples available. White River DNA is currently taken from natural origin broodstock and all natural origin fish passed upstream of the Buckley Dam facility.

DNA baseline data were collected by NOAA for TRT analyses using samples from Nisqually River winter steelhead juvenile life history studies from 2006 to 2008, which were provided by Nisqually tribal staff. Many of the smolts genetically sampled were also implanted with acoustic tags. Other samples were collected recently from occasional steelhead sampled in the chum fishery. No DNA samples are taken routinely at this time from the juvenile migrant trap.

No baseline DNA information is available for South Sound or East Kitsap populations.

ONGOING VSP MONITORING AND NEW FUNDING PROPOSALS

Salmon and steelhead monitoring was evaluated and categorized as ongoing or proposed for funding based upon the critical gaps identified by the field biologists for the different regions of Puget Sound. Ongoing monitoring is identified in the tables as "ONGOING". Proposed funding was ranked according to its importance into HIGHEST, HIGH, and LOWER importance. All monitoring has been assigned a number for ease in finding specific items. All of the VSP tables, proposals and summary table rankings can be found at http://mypugetsound.net. Due to the economic constraints currently being implemented, many programs that were ONGOING in 2011 are now at risk in 2012. As a result, ONGOING monitoring and 2011 identified gaps are placed in the same tables in order to be able to review the entire gamut of monitoring needs and gaps in one location. Any funding discussions will need to review ongoing monitoring as well as proposed new monitoring.

Puget Sound Chinook

The following figure reflects the degree of ongoing Chinook monitoring funding and the relative size of the proposals for additional monitoring by MPG in Puget Sound

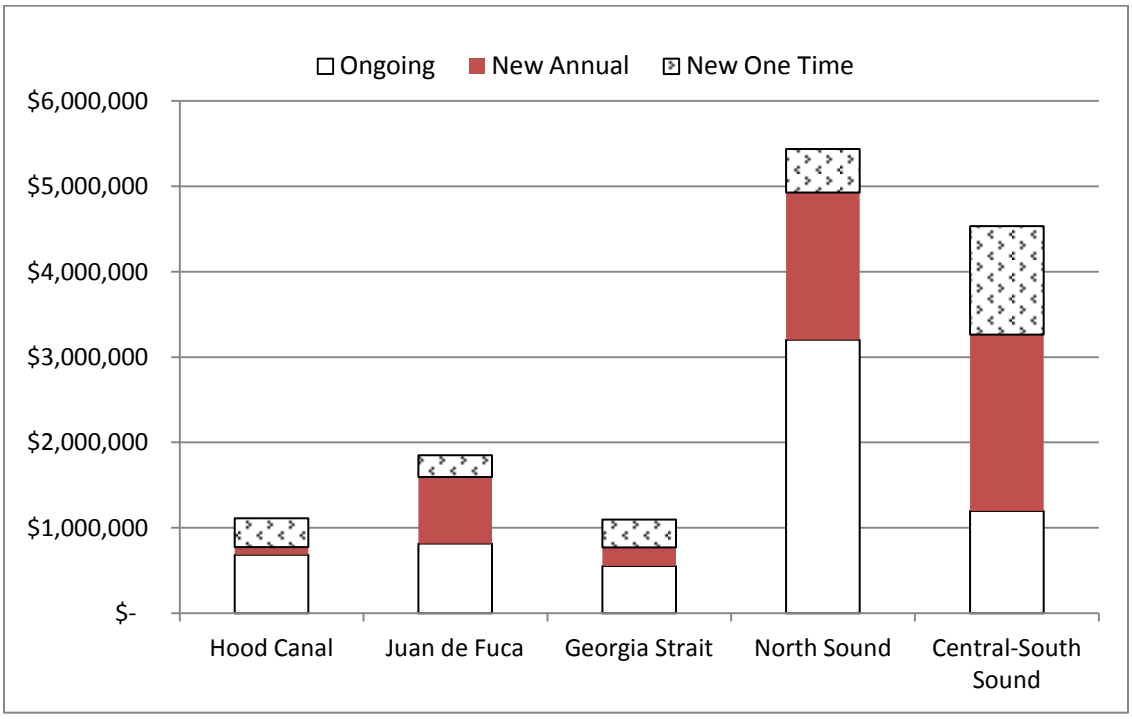


Figure 14. Ongoing costs and costs for implementing ranked priorities by MPG.

The proposals from the co-managers reflect the overall priorities to develop the most important information which is the number of returning adults, assessment of number of migrants produced in the

existing habitat from the stream of origin; and the number of adults in the returning population (catch and escapement. Other KEAs are also addressed but not to the extent that the above components have been derived.

Hood Canal

The Hood Canal MPG contains the Skokomish fall Chinook population and the Mid Hood Canal Chinook which is a conglomerate of a number of smaller streams that empty directly into Hood Canal. The WDFW, Skokomish Tribe, Port Gamble S'Klallam Tribe, Point No Point Treaty Council, Hood Canal Salmon Enhancement Group, and Long Live the Kings have partnered to monitor Chinook. The funding for monitoring has been obtained from a variety of sources some of which is funded on an annual basis and is at risk. It is considered at risk because it relies upon annual grants awarded from more than one funding entity on an annual competitive basis.

Strait of Juan de Fuca MPG

The Strait of Juan de Fuca area contains the Dungeness and Elwha Chinook populations. The Elwha is currently undergoing a radical change with the removal of the one hundred year old Elwha and Glines Canyon dams and the reintroduction of salmon and steelhead populations back into their blocked historic range. The monitoring of conditions both pre and post removal is critical in order to document the successes and problems with reintroduction. Elwha Chinook adults are monitored with a combination of a floating weir and DIDSON sonar at the same location. Juvenile migrants are counted with a migrant screw trap. Hatchery "safety net" populations are planned to ensure that current remnant stocks are not eliminated due to sedimentation and other risks when the dam is removed. Tracking of effects of hatchery programs on genetics and reintroductions are of concern. Also, the ability to track changes in spatial distribution in the watershed will be very important for future evaluations and for predicting what may occur in other watersheds where access is restored.

The highest priority for the Elwha River is to be able to track the recovery of Chinook in the basin and their re-distribution throughout the watershed. To accomplish this:

- More juvenile migrant traps are needed in the watershed to track tributary production (Proposal #22, $240,000) ;
- All hatchery fish should be marked with a CWT and otolith mark so that they can be detected and separated from naturally produced salmon from the watershed (Proposal #20, $330,000);
- Conduct extensive foot surveys of adult Chinook spawning as they re-enter the watershed accompanied by radio tagging of a select number of spawners (Proposal #23, $160,000).

The Dungeness population also has its own problems with Chinook and monitoring is in need of additional funding to fill critical gaps. In the Dungeness, monitoring is proposed to address the limiting factor of sedimentation and predation upon Chinook egg and fry survival (Proposal #19).

Georgia Strait

The Georgia Strait Chinook MPG includes the North Fork and South Fork Nooksack Chinook populations in Whatcom and Skagit Counties. The North Fork population encounters the effects of glacial flour on visibility and flow. Population estimates are not considered accurate and there are efforts underway to improve them. They have identified the juvenile migrant trap and the current ongoing spawner abundance surveys as the most crucial ongoing items to maintain. Also important is the tracking of the success of the releases of the captive brood program.

Proposed additional monitoring in the Nooksack has focused on improving estimates of adult spawners and improving juvenile abundance estimates for both North Fork and South Fork. In addition, they are proposing to implement a study of the effects of supplementation on natural production by implementing a genetic mark recapture (GMR) project. This may allow differentiation of North Fork and South Fork juveniles at traps, in the estuary and elsewhere and improve estimates of adult spawners with known precision.

North Puget Sound

Proposed additional monitoring for the Skagit would obtain information that will allow the parsing out of the six Chinook populations. This needs to be possible in the migrant trap and elsewhere in the watershed and to make estimates of their abundance. For the Stillaguamish system, the major emphasis is nearshore sampling for juvenile abundance. In the Snohomish, improvements to estimates of natural origin and hatchery origin spawners are proposed as well as more efficient trapping of juvenile migrants.

Central-South Sound MPG

Central-South Sound MPG consists of the TRT populations for the Cedar River, Sammamish tributaries, Green-Duwamish, Puyallup, White, and Nisqually rivers. In summary, funding proposals fall under improved juvenile and adult abundance estimates:

Table 13. Highest Priority Chinook Ongoing Monitoring and New Funding Proposals To Fill Critical VSP Gaps

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
HOOD CANAL MAJOR POPULATION GROUP								
1	**ONGOING**	**Hamma Hamma Outmigrant Trapping (Jan-June).**	WDFW, LLTK	Continues ongoing juvenile migrant information for all species in Hamma Hamma River. A screw trap has been installed on the Hamma Hamma River since 2002. A supplementation program was initiated on the Hamma Hamma River in 1995 to rebuild Chinook abundance.	SRFB #11-1649 LLTK, funding is tenuous.* Indirectly funded year-to-year	$ 20,000		
2	**ONGOING**	**Duckabush Outmigrant Trapping (Jan-June).**	WDFW	Continues ongoing juvenile migrant information for all species in Duckabush River. Trapping is not adequately funded for full extent of outmigration of all species being trapped (Chinook, summer chum, and steelhead). Funding source for chum outmigration (January - May) is not secure. Screw trap in place annually for steelhead (April-May); need to trap entire summer chum outmigration timing each year (Jan-May.	WDFW, SRFB #11-1649 (FIFO, year to year and tenuous)	$ 80,000		
3	**ONGOING**	**Skokomish Chinook** Adult and Juvenile migrant monitoring.	Skokomish Tribe & WDFW	The number of spawners is estimated by a total redd count * 2.5 Fish per redd. Purdy Creek is not surveyed. No estimate of precision. Hatchery/wild composition: coded wire tags in the past but now hatchery fish are marked and identified. Screw trap present but upstream of most spawning activity.		$240,000		
4	**ONGOING**	**Skokomish Chinook Spawner survey (escapement, spatial distribution, diversity,**	Skokomish tribe	Provides estimate of number of adult Chinook spawners in SF Skokomish.	Existing Monitoring by Skokomish	$ 22,035 `		

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
		h/w, etc).			Tribe (PCSRF) Existing Monitoring but funding is tenuous.			
5	**ONGOING**	**<u>Mid Hood Canal Chinook</u>** Chinook Adult abundance Spawner surveys.	WDFW	Abundance: Chinook escapement is estimated in the Hamma Hamma, Duckabush, and Dosewallips watersheds. In the Hamma Hamma River, escapement is estimated from counts of cumulative new redds and/or from live Chinook using the AUC method. In the Dosewallips and Duckabush Rivers, escapement is estimated from a combination of counts of live Chinook and redds. Surveys are conducted every 7 to 10 days on all three rivers from late August or early September through October.	WDFW, Existing Monitoring	$20,000		
6	**ONGOING**	**Floating Weir Operation**	Pt Gamble S'Klallam Tribe	Floating weir operation to determine efficiencies and to debug.		$305,231		
7	**HIGHEST**	**<u>Mid Hood Canal Chinook</u>** Install flow gauge in Hamma Hamma River.	TBD	Flow gauges: $12-$25,000/stream for installation (USGS and WDOE) AND $15-$18,000/year to operate. An alternative is to buy and operate independently, but may require significant ongoing operation cost.	TBD		$18,000	$ 25,000
8	**HIGH**	**<u>Four flow gauges</u>**: Install flow gauges Dewatto, Union, Lilliwaup, and Tahuya.	USGS and WDOE	There is a lack of information concerning the effect of flow on scouring of redds, and low flow impacts to spawning areas of chum salmon and Chinook.	TBD		$72,000	$100,000

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
9	**HIGH**	**Mid-Hood Canal Chinook Evaluation (rough estimate - seeking other funding) Duckabush, Dosewallips, Hamma Hamma.**	LLTK, NOAA, WDFW, PGST	Evaluate current stock behavior and performance as it relates to the possible life-history of the historic stock; historic, present and future ecosystem function; and ecological interactions. Propose approach for moving forward toward recovery.	TBD			$150,000
10	**LOWER**	**Hood Canal MPG.** Conduct and continue pilot nearshore study of juvenile **Chinook and chum** salmon habitat utilization, Nearshore, presence and utilization, habitat preference, acoustic surveys, evaluating techniques - Hood Canal and Admiralty Inlet 6 year study.	Port Gamble S'Klallam Tribe, NOAA, SRSC	Nearshore studies - (1. Wild Fish Conservancy - pilot nearshore study of juvenile salmon habitat utilization, proposed to SRFB for funding - lead, Micah Waitt 2. Port Gamble S'Klallam Tribe in partnership with NOAA & SRSC- Nearshore, presence and utilization, habitat preference, acoustic surveys, evaluating techniques - Hood Canal and Admiralty Inlet - EPA, Puget Sound Partnership and PCSRF - 6 year funds probable.	SRFB, PSP, USEPA			
11	**LOWER**	**Dosewallips River** **All Species** Purchase and Install a **juvenile migrant trap**.	Port Gamble S'Klallam Tribe	Provides estimate of freshwater production of juvenile chum, steelhead, and Chinook. The Port Gamble S'Klallam Tribe is interested in establishing the out-migrant trapping as a priority 1 project; however, the group had in the past discussed reasons for it not to be including concerns about the feasibility of trapping in the Dosewallips, the relative need as we are trapping in two of the three mid-Hood Canal streams where we already have funding needs to keep the operations going, and that this is a concept in its earlier stages.	TBD			$50,000
12	**LOWER**	**Skokomish River Chinook Spawning Habitat Suitability Survey** in Hunter Creek. Mark-Recapture Study.	Skokomish Tribe & WDFW	Determine if fish entering Purdy Creek are utilizing available habitat for spawning, migration to George Adams Hatchery or are dipping into Purdy Creek and exiting back to main stem.	Skokomish Tribe, WDFW, or City of Tacoma			$5,000

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
13	**LOWER**	**Skokomish River Chinook Mark-recapture Purdy creek utilization.**	Skokomish tribe	Develops estimate of total numbers of Chinook in Purdy Creek.	Skokomish Tribe (PCSRF), WDFW, or City of Tacoma			$5,000
				HOOD CANAL MPG TOTALS		**$687,266**	**$90,000**	**$335,000**
JUAN DE FUCA MAJOR POPULATION GROUP								
14	**ONGOING**	**Dungeness Chinook** Adult and Juvenile migrant monitoring.	WDFW, JSKT,	Ongoing Dungeness monitoring conducts adult spawner surveys in the watershed and operates a smolt trap near the mouth. Current monitoring has problems with trap efficiency and water clarity.	WDFW State Funds, JSKT PST CWT Funds,	$ 98,600		
15	**ONGOING**	**Elwha Chinook SONAR** Adult migrant monitoring.	LEKT, WDFW, NOAA	Design and implement Elwha comprehensive spawning ground surveys and sampling. Sonar used as experimental estimate and weir used as adult counting site at RM 3.3. Operates up to 2,000 cfs. Sonar will be used for steelhead and coho but may be usable for all species. Weir funded only through 2012. Sonar funding is limited as well. Sonar estimate was double estimate produced by redd surveys. Precision estimate approximated CV standards at ± 17.0%. Elwha Tribe conducts juvenile migrant monitoring.	NOAA, USFWS, USGS, NPS, EPA	$289,430		
16	**ONGOING**	**Elwha Chinook Floating Weir**	LEKT, WDFW, NOAA	NOAA-USFWS-USGS Stimulus funded construction and operation of weirs. NPS provided staff for weir. 2012 weir is EPA Puget Sound estuary funds. Sonar funding through EPA through 2012. Tagging paid for through NP	NOAA, USFWS, USGS, NPS, EPA	$288,400		

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
				foundation. Otolith marking funded by NP Foundation and otoliths read using WDFW state dollars. Spawner survey work from WDFW funds.				
17	**ONGOING**	**Elwha Juvenile Fish Surveys**	LEKT			$65,000		
18	**ONGOING**	**Elwha Rotary Screw trap Operations**	WDFW	Operate and maintain screw trap at mouth of Elwha to enumerate migrating juvenile Chinook and steelhead		$75,000		
19	**HIGHEST**	**Dungeness Chinook** Evaluate freshwater redd survival and fry predation.	NOAA NWFSC	Losses of Dungeness fish production due to sedimentation and other causes are not known. This proposal would determine mortality of egg to fry survival using Vibert boxes. Conduct redd survival estimates for washouts. Need a directed study to assess survival from egg to migration.	TBD		$77,000	$ 25,000
20	**HIGHEST**	Mark all **Elwha Hatchery Chinook** so that they are detectable at all locations.	WDFW	Currently about 10% of hatchery release marked. Prefer to CWT mark all hatchery products coupled with otolith marks to determine hatchery component. Without 100% marking it is not likely that the results of natural production will be easily evaluated in the watershed. Provides ability to detect Elwha Chinook in all fisheries and on spawning grounds and nearshore areas.	TBD		$330,000	
21	**HIGH**	**Juan de Fuca Chinook MPG** Straits DNA evaluation for nearshore Chinook and steelhead.	NOAA NWFSC	Beach Seine sites have been implemented at selected sites from Discovery Bay to Neah Bay for sampling juvenile salmon and steelhead. Current effort is not funded and DNA analysis is needed to parse out contributing Puget Sound stocks.	NOAA NWFSC Mscl.		$125,000	

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
22	**HIGH**	**Elwha Chinook** Add 3 more Elwha juvenile migrant traps.	TBD	Desire to add three more juvenile migrant screw traps to upper Elwha River from Feb to June. This will allow sub-basin evaluation of increase in natural production. $30K/trap for operation and $50K/trap to purchase. Equals $90K/year to operate and $150K for one time purchase.	Not Identified		$90,000	$150,000
23	**HIGH**	**Elwha Chinook** Fund Foot Surveys and radio telemetry of **r**e-colonization.	Elwha Tribe, WDFW, NPS	Need to be able to track re-colonization of Chinook in the upper watershed using foot surveys and radio telemetry.	TBD		$80,000	$80,000
24	**LOWER**	**() Elwha Chinook** **Evaluate freshwater redd survival and fry predation.** Evaluate production from freshwater by evaluating redd survival, predation, and other effects.	TBD	Need to look at egg to fry survival at various locations. 75K/year to do egg to fry survival using Vibert boxes. Conduct redd survival estimates for washouts $2K.	TBD		$77,000	
				JUAN DE FUCA MPG TOTALS		**$816,430**	**$779,000**	**$255,000**
GEORGIA STRAIT MAJOR POPULATION GROUP								
25	**ONGOING**	**Nooksack Chinook** Maintain Nooksack Juvenile migrant monitoring trap at current level.	Lummi Nation	Current operation of the Nooksack juvenile migrant trap is essential for estimating out migrants.	PCSRF and Lummi	$150,000		

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
26	**ONGOING**	**Nooksack Chinook** Annual Nooksack spawner Surveys for Chinook.	WDFW, Nooksack Tribe, Lummi Nation	Surveys conducted 1-8 times per season, depending on conditions. Efforts are underway to resume more thorough surveys and develop a system-specific estimate. Total spring Chinook escapement to the Nooksack is estimated by a combination of redd count and carcass count expansions.	Dingell Johnson - Wallup Breaux and mass mark funding. More funding is needed to adequately survey and to run DNA and otoliths. That need will grow once South Fork releases begin to return.	$200,000		
27	**ONGOING**	**Nooksack Chinook Adult Spawner DNA analysis**	Lummi Nation	Monitor ongoing DNA of hatchery and natural adult spawning Chinook		$5,500		
28	**ONGOING**	**Nooksack Chinook Radio Tagging**	Lummi Nation	Radio tagging population estimate of Chinook by stock, time of migration, and destination		$200,000		

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
29	**HIGHEST**	**<u>NF&SF Nooksack Chinook</u>** **GMR DNA sampling** for NF and SF.	Lummi Nation, Nooksack Tribe and WDFW	(1)Spawner abundance estimates are not consistent and accurate due to turbid glacial water conditions. Need improved spawner abundance estimation procedures that can be applied consistently in turbid water that will give, through sibling analysis, a good estimate (with 95% CI) of effective number of breeders for the two populations. Approximately 5,000 samples. Lab coast $43/ sample. Includes Analysis.	**TBD**		$54,000	$ 264,880
30	**HIGHEST**	**<u>Nooksack River Chinook</u>** **Complete analysis and evaluation of backlogged otoliths.**	TBD	Estimates of stray rates and status of restoration of the natural run is not well understood. A backlog of otoloth information has not been processed in the laboratory and is not available for evaluation.	TBD			$10,000
31	**HIGH**	**Nooksack River Spawner abundance coverage**	Nooksack	Outfit and fund a second spawner survey crew from July through September to improve coverage of NF spring Chinook areas.	TBD		$27,000	
32	**HIGH**	**<u>NF Nooksack Chinook</u>** Fund Improved estimates of migrant trap efficiency.	Lummi	Juvenile trap needs to be operated for all 24 hour periods and calibrated to provide known precision. Current calibration is based on hatchery Chinook 0+ released upstream in mark recapture process. Use of Didson or other echo sounders to compare with migrant trap. Also access for evaluating DNA siblings.	TBD		$75,000	
33	**HIGH**	**<u>Nooksack Spring Chinook</u>** Evaluate supplementation program.	WDFW, Nooksack, and Lummi	Impact of supplementation on relative reproductive fitness of Nooksack natural Chinook is not known. Need to estimate gene flow from genetic analysis of juveniles sampled and adults used in Supplementation program. Use BA or BACI design. (Need for juvenile migrant information to detect freshwater productivity from supplementation program. That includes: 1) More surveyor crews, and especially for the North Fork, though also the South Fork given anticipated increased HOR abundances. 2) Appreciable funding for adult otolith	TBD		See GMR funding	

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
				analysis and for adult DNA analysis and new NMT hammer wands for crews. We'll need that for the S Fk releases too, concluding for their cwt detection.				
34	**HIGH**	**South Fork Nooksack Chinook** Fund a migrant trap.	Nooksack	Need for juvenile migrant trap in the SF for estimating smolt to adult (SAR) in SF and for retrieval of DNA sibling analysis.	TBD		$35,000	$50,000
35	**HIGH**	**Kendal Creek Hatchery Brood Stock Program Genotyping**	Nooksack	Genotype Kendall N/M Fork rebuilding program brood stocks 450 per year to provide known parents of HOR that return 3-5 years later and the grandparents of natural adults produced from those. Begin understanding the amount of HOR contribution of NOR adults.	TBD		$25,000	
				GEORGIA STRAIT MPG TOTALS		**$555,500**	**$216,000**	**$324,880**
NORTH SOUND MAJOR POPULATION GROUP								
SKAGIT WATERSHED								

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
36	**ONGOING**	**HATCHERY REFORM** **Skagit Chinook** Evaluation of Skagit Hatchery Straying.	Skagit System Coop	Funding provided by RCO administered PCSRF funds to evaluate adult hatchery strays at Marblemount hatchery as part of hatchery reform.	PCSRF Hatchery reform	$ 28,891	$ 28,891	
37	**ONGOING**	**Skagit Chinook** Skagit IMW.	Skagit System Coop	Partial funding for Skagit nearshore marine and tidal sampling of Chinook as part of intensively monitored watershed to determine effects of estuary rearing on Chinook production.	SRFB Project #11-1633	$150,000		
38	**ONGOING**	**Skagit Chinook** Skagit IMW Habitat Monitoring.	NOAA NWFSC	Partial funding for sampling nearshore salmon habitat in Skagit Bay.	SRFB Project	$100,000		
39	**ONGOING**	**Skagit Chinook** Skagit IMW.	Skagit Coop	Partial funding for Skagit nearshore marine and tidal sampling of Chinook.	NWIFC PST Funds	$253,000		
40	**ONGOING**	**Skagit Chinook** Skagit IMW. Downstream juvenile migrant trapping.	WDFW	Funding provided for juvenile migrant monitoring as part of the WDFW contribution to the Skagit IMW.	Dingell-Johnson Funds	$216,750		
41	**ONGOING**	**Skagit Chinook** Skagit Adult Chinook spawner abundance monitoring.	WDFW	Skagit River is flown every other week. Based on redd life. The assumed redd life of 21 days is based on a 1973 study. Estimates are made by calculating (AUC) area under the curve.	WDFW WLS-Wallup Breaux	$148,000		
42	**ONGOING**	**Skagit Chinook Spawning Ground Surveys**	Upper Skagit Tribe	Conduct spawning ground surveys in Skagit River. Upper Skagit contribution 20%	Upper Skagit Tribe	$22,000		
43	**ONGOING**	**Skagit Chinook Escapement Processing**	Upper Skagit Tribe	Chinook escapement data processing and CWT/scale processing. Monitor contribution of Marblemount Chinook to the fishery/hatchery. Upper Skagit contribution 40%	Upper Skagit Tribe	$16,000		

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
44	**ONGOING**	**Skagit Chinook test fisheries**	Upper Skagit Tribe	Conduct coho test fishery	Upper Skagit Tribe	$30,000		
45	**ONGOING**	**Skagit Chinook and Coho fisheries**	Upper Skagit Tribe	Sampling of Chinook and coho commercial and test fisheries	Upper Skagit Tribe	$71,000		
46	**ONGOING**	**Skagit Summer Chinook Broodstock**	Upper Skagit Tribe	Collect broodstock for summer Chinook indicator stock	Upper Skagit Tribe	$1,000		
47	**ONGOING**	**Skagit Chinook Stray rate study**	Upper Skagit Tribe	Survey, sample, data processing, data analysis and reporting of Chinook stray rate. Upper Skagit contribution 7%.	Upper Skagit Tribe	$2,000		
48	**ONGOING**	**Skagit Chinook Marblemount CWT marking**	Upper Skagit Tribe	Acquire and apply 400,000 CWTs for double index tagging ongoing annually but needs stable funding source per 2012 PBD release number @$163/1,000 fish. Upper Skagit contribution.	TBD	$16,685		
49	**ONGOING**	**Skagit Chinook Marblemount CWT marking**	Upper Skagit Tribe	Acquire and apply 187,000 CWTs for Marblemount Hatchery spring Chinook single index tag converts mass marked fish to SIT ongoing annually 2012 PBD release number @$163/1,000 fish. Upper Skagit contribution 37%	TBD	$11,307		
50	**ONGOING**	**Skagit Chinook Run Size Forecast**	Upper Skagit Tribe	Develop Skagit Chinook run size forecast estimate using ecosystem indicators. Annual	TBD	$25,000	$25,000	
51	**HIGHEST**	**Skagit Chinook** Complete GMR DNA sampling for Skagit populations.	TBD	Begin a DNA mark recapture of juvenile and adult Chinook salmon on the spawning grounds and at the migrant trap for all Skagit populations. Need for full parental genotyping by Skagit populations in order to: (1) determine if there are different life history and survival characteristics among the populations; (2) parse out the juvenile migrants from the six populations at the juvenile	**TBD**		$54,000	$ 264,880

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				trap and returning adults in the watersheds. Possible need for relative reproductive study of effect of indicator hatchery program on wild fitness based on 5,000 samples.				
52	**LOWER**	**Increase Lower Sauk Chinook redd ground surveys.**	WDFW	Redd counts do not have ability to estimate precision or accuracy. Spawner surveys vary depending upon water conditions.	TBD		$5,000	
53	**LOWER**	**Lower Sauk summer Chinook Determine PHOS.**	TBD	PHOS is not determined with accuracy at this time so cannot determine effect of hatchery fish on spawners.	TBD		?	?
STILLAGUAMISH WATERSHED								
54	**ONGOING**	**HATCHERY REFORM** **Stillaguamish Chinook** Smolt production estimation.	Stillaguamish Tribe	Submitted to RCO as part of Stillaguamish hatchery reform package for Puget Sound.	PCSRF Hatchery Reform	$99,993	$99,993	
55	**ONGOING**	**Stillaguamish Chinook** Implement NF Stillaguamish Chinook GMR study.	Stillaguamish Tribe and WDFW	Current migrant trapping information is unable to separate NF and SF migrants. Accuracy of AUC estimates of NOR are questionable and broodstock contribution to NOR is not known. The GMR method provides estimates of total escapement and effective number of breeders with 95% confidence interval.	Program PSC Southern Fund.	$117,000		
56	**ONGOING**	**HATCHERY REFORM** Broodstock and genetics Monitoring Stillaguamish River	Stillaguamish Tribe	Ongoing monitoring for hatchery related programs is at risk due to soft money and budget cuts. Monitoring includes: Chinook Broodstock sampling; Chinook spawner ground survey; Chinook cwt/scale processing; Genetics monitoring; Coho spawner ground surveys; Chum genetics management, Chum spawner ground	PCSRF Hatchery reform and other sources	$486,000	$486,000	

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
				surveys				
57	**ONGOING**	**Stillaguamish Chinook NF CWT Tagging**	Stillaguamish Tribe	Ongoing CWT tagging of Chinook releases		$50,000		
58	**ONGOING**	**Stillaguamish Chinook CWT/scale processing**	Stillaguamish Tribe	Collect and process scale samples and CWT snouts		$3,000		
59	**ONGOING**	**Stillaguamish Chinook** Spawner abundance monitoring (escapement estimation)	WDFW	Adult abundance monitoring – spawning ground surveys in-river and aerial.	WDFW	$89,000		
60	**HIGHEST**	**Captive Brood Program** Stillaguamish Chinook Brenner Hatchery	Stillaguamish Tribe	New program to safeguard Chinook program in South Fork. Funding at risk	NEW		$335,000	
SNOHOMISH WATERSHED								
61	**ONGOING**	**ONGOING Tulalip Hatchery Thermal marking of hatchery raised Chinook, coho,**	Tulalip Tribes	Implement 100% Tulalip Hatchery Chinook mass (thermal otolith) marking requirement';	ONGOING but funds are uncertain	$7,500		
62	**ONGOING**	**Tulalip Hatchery Adipose fin clipping**	Tulalip Tribes	Implement 100% Tulalip Hatchery Chinook a mass adipose fin marking	ONGOING but funds are uncertain	$76,500		

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
63	**ONGOING**	**Tulalip Hatchery CWT Chinook and coho**	Tulalip Tribes	Acquire & apply 200,000 CWT's for Tulalip Chinook;	ONGOING but funds are uncertain	$27,000		
64	**ONGOING**	**Tulalip Hatchery Analyze Snohomish and Tulalip Chinook and coho otolith, CWT, and scale samples**	Tulalip Tribes	0.8 FTE lab tech and sampling manager+ fringe, supplies, incidentals, indirect (see budget)	ONGOING but funds are uncertain	$152,032		
65	**ONGOING**	**HATCHERY REFORM Tulalip Hatchery Skykomish Chinook Broodstock Integration**	Tulalip Tribes	Continue implementing Sky. Chin.& coho nat.-origin broodstock integration: ongoing annually but needs stable funding source, Tulalip contribution, 0.25 FTE	PCSRF Hatchery Reform	$15,242	$15,242	
66	**ONGOING**	**Tulalip Hatchery Operate smolt traps**	Tulalip Tribes	Operate smolt traps on Skykomish and Snoqualmie Rivers: Ongoing annually but needs stable funding source, $125K/trap, all expenses for 5 months, 12, 0.4 FTE fish. techs	ONGOING but funds are uncertain	$250,000		
67	**ONGOING**	**Snohomish Chinook** Migrant trapping in Skykomish and Snoqualmie.	Tulalip Tribes	Juvenile migrant traps in the Skykomish and Snoqualmie help determine freshwater production and improvements in production due to habitat improvements and restoration.	Tulalip Tribes	$400,000		
68	**ONGOING**	**Snohomish Chinook** Adult salmonid population monitoring.	Tulalip Ttribes & WDFW	Snohomish adult abundance monitoring is essential for determining the status of the ESA listed populations. Helicopter, boat & foot surveys used for redd estimates.	PCSRF PRISM project #11-1653 & WDFW	$62,217 & $129,000	$62,217	
69	**ONGOING**	**Snohomish Chinook Juvenile monitoring in the lower mainstem river out to the nearhsore**	NOAA Fisheries and Tulalip Tribes	Use of beach seines and fyke traps year round to determine density size and species composition of all fish in the estuary with focus on Chinook. Intended to inform status/trends and also possible densities increased from dyke removal.	NOAA NWFSC & Tulalip Tribe	$255,000		
70	**ONGOING**	**HATCHERY REFORM Snohomish Chinook** Hatchery Broodstock integration and analysis.	NWIFC, Tulalip Tribes & WDFW	Conduct genetic integration and sampling of Snohomish Chinook broodstock during egg takes for the joint program. Collect tissue samples for DNA analysis, process stock assessment samples at Tulalip, contract the DNA work, and use results to improve estimates of gene flow. Objective 1: Assist with conducting annual	RCO PCSRF 11-1653 Hatchery Reform & WDFW	$74,539 & $12,500	$74,539	

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
				broodstock integration to achieve PNI goal of 0.5 - 0.7; Objective 2: Estimate gene flow and effective population size with genetic data using multiple techniques and compare the 95% confidence interval for each estimated parameter to verify absence of bias of the estimates. Use the best estimate of each parameter to calculate PNI.				
71	**ONGOING**	**HATCHERY REFORM** **Snohomish Chinook** Tulalip hatchery Chinook and coho Contribution.	Tulalip Tribes & WDFW	Stock Assessment Laboratory (TSAL) and WDFW. Use results to estimate the contribution rate of hatchery- and natural-origin Chinook and coho to the hatcheries, terminal-area fisheries and contribution of Tulalip Chinook to natural escapement. Objective 1: Thermally mark 100% of Tulalip Hatchery Chinook and coho. Objective 2: Estimate the contribution rate of Tulalip Hatchery Chinook to Snohomish natural spawning populations. Objective 3: Estimate contribution of Tulalip Hatchery Chinook and coho to the Area 8D fishery; Objective 4: Estimate the contribution of Tulalip Hatchery Chinook to Tulalip and Wallace Hatchery escapements; Objective 5: Read otoliths, scales, and CWT's at the Tulalip Stock Assessment Laboratory with an error rate of < 5% per quality control of paired samples of 200 fish also read at WDFW; Objective 6: Read otoliths, scales, and CWT's at WDFW and Tulalip laboratories with an error rate < 15% when compared with fish of known Tulalip origin per the presence of a CWT.	RCO PCSRF 11-1653 Hatchery Reform	$62,217	$62,217	
72	**HIGHEST**	**Snoqualmie Chinook** Increase juvenile trapping effort and trap efficiency.	TBD	Increase juvenile trapping effort and trap efficiency. Need to increase number of NOR trapped to determine parental genotyping.	TBD		$100,000	

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
73	**HIGH**	**<u>Skykomish Chinook</u>** Increase juvenile trapping effort and trap efficiency.	Tulalip Tribes	Need to increase number of NOR trapped to determine parental genotyping.	TBD		$100,000	
74	**HIGH**	**<u>Skykomish Chinook.</u>** Procure and install thermal marking system at Wallace River Hatchery.	Tulalip Tribes	Conduct gene flow monitoring consistent with HAIP discussions. pHOS from Wallace could be indirectly gotten at using CWT	TBD		$20,000	$120,000
75	**HIGH**	**Tulalip Hatchery Skykomish Chinook estuary monitoring**	Tulalip Tribes	Monitor ecological. interactions, manage risk between juvenile hatchery/natural fish in the Snohomish estuary: periodic unfunded monitoring need, 0.25 FTE, fringe and indirect to sample before and after hatchery releases utilizing existing freshwater smolt traps, beach seining and fyke netting in estuaries and nearshore marine areas	NEW Not Funded		$21,014	
76	**HIGH**	**<u>Snohomish Chinook</u>** Obtain fecundity information of natural fish.	WDFW	Need information on fecundity of natural fish to verify validity of using hatchery fecundity data.	TBD			$25,000
77	**HIGH**	**<u>North Sound Chinook MPG</u>** Expand Nearshore Sampling for Snohomish Estuary.	TBD	Distribution and survival of Chinook juveniles in Snohomish nearshore area is not well known.	TBD		$191,000	

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
78	**HIGH**	**<u>North Sound Chinook MPG</u>** Analyze Backlog of Nearshore otolith, stomach, scale, and DNA samples.	TBD	Past data collected for North Sound nearshore areas has not been processed and analyzed and may provide valuable new information.	TBD			$100,000
79	**HIGH**	**<u>North Sound Chinook MPG</u>** Continue Nearshore Beach Seining Sites Mukilteo to Whidbey-Camano.	TBD	Past beach seine data have provided some information on timing, distribution, and stock composition of selected nearshore locations in Puget Sound.	TBD		$50,000	
80	**LOWER**	**<u>All Chinook</u>** Evaluate migrants passing through San Juan Islands.	NOAA	Increase estuary sampling of Chinook in the San Juan Islands for Skagit origin Chinook migrants Need additional information on migration route of Whidbey Basin Chinook through San Juan's and Straits.	TBD		NA	
81	**LOWER**	**<u>Skykomish fall Chinook</u>** **Develop life cycle model to estimate marine survival and preseason forecasts through statistical relationships.**	TBD	Life cycle models attempt to illustrate where limiting factors are occurring in the life cycle of Skykomish fall Chinook and to what extent marine survival and current preseason forecasts are accurate and useful.	TBD		$10,000	
				NORTH SOUND TOTALS		**$3,460,373**	**$1,722,734**	**$509,880**

CENTRAL-SOUTH SOUND MAJOR POPULATION GROUP

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
SAMMAMISH – LAKE WASHINGTON WATERSHED								
82	**ONGOING**	**<u>Central-South Sound MPG</u>** Kitsap Nearshore Salmon Utilization Assessment.	Suquamish Tribe	This project summarizes the results of nearly 10 years of monitoring of the distribution and abundance of fish species (including salmon and forage fish) in the nearshore marine zone on Bainbridge Island, Miller Bay, Liberty Bay, and other areas on the East and North shores of the Kitsap Peninsula. All data (including species data and water quality data) will be validated, recorded, and archived in a relational data base. Summary reports of data and findings will be described in summary reports (one report on all Kitsap County data and a separate report for data collected at Keyport Lagoon).		$ 61,305		
83	**ONGOING**	**ONGOING** **<u>Sammamish- Cedar Chinook</u>** A Telemetry/Mark-Recapture Study of Fall Chinook Salmon in the Lake Washington Basin.	Muckleshoot	Use ultrasonic telemetry technology and mark-recapture techniques to estimate total abundance, stock composition, run timing, migration characteristics, and spawning abundance of Chinook salmon in the Lake Washington basin.	NWIFC PCSRF	$251,500		
84	**ONGOING**	**ONGOING** **<u>Sammamish- Cedar Chinook</u>** Spawner abundance monitoring (escapement estimation)	WDFW	Adult abundance monitoring – spawning ground surveys in-river.	WDFW	$50,000		
85	**HIGHEST**	**<u>Sammamish - Cedar Chinook</u>** The Army Corps of Engineers should replace the gate valves and the fish ladders at Ballard locks.	Army Corps of Engineers	The Hiram Chittenden locks are obsolete and kill adult and juvenile salmon and steelhead passing through them. The facilities should be redesigned and replaced to allow for adequate passage and monitoring of ESA listed populations.				$ 20,000,000 (Note: this is not part of total for HIGHEST priorities)

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
86	**HIGHEST**	**<u>Sammamish Chinook</u>** Fund installation of juvenile migrant trap in Issaquah Creek.	WDFW	Need to document production of major portion of Sammamish basin natural origin Chinook.	TBD		116,000	$50,000
87	**HIGH**	**<u>Sammamish – Cedar Chinook</u>** Develop survival estimates of Cedar Chinook juveniles passing through Lake Washington and the ship canal.		It is believed that a significant mortality occurs of Cedar and Sammamish Chinook fry and smolts before they reach the sea in Lake Washington and in the ship canal.	[may already be included in King Co. contract w/ WDFW]		$NA	
88	**HIGH**	**<u>Sammamish Chinook</u>** Complete Sammamish Chinook mark recapture study of juvenile migrant survival.	King Co., WDFW	Lack of information on survival of Sammamish Chinook in Lake Sammamish, Lake Washington and Ship Canal.	TBD		$300,000	$200,000
GREEN RIVER WATERSHED								
89	**ONGOING**	**ONGOING** **<u>Green River Chinook</u>** PSC Green River Sentinel Stocks Program.	WDFW	This PSC program provides funding for exploring GMR parentage method to determine Chinook escapement and associated precision of estimates.	PSC Sentinel Stock Program	$150,000		
90	**ONGOING**	**ONGOING** **<u>Green River Chinook</u>** Spawner abundance monitoring (escapement estimation)	WDFW	Adult abundance monitoring – spawning ground surveys in-river and aerial.	WDFW	$86,000		

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
91	**HIGH**	**Green River Chinook** Provide for long term funding of Green R. main stem juvenile trap upstream of Soos Creek.	WDFW	Funding for downstream migrant trap is at risk upstream of Soos Creek on the Green River.	TBD		$116,000	
92	**HIGH**	**Green River Chinook** Fund an increase in frequency of adult ground surveys	WDFW	Green River Chinook Redd count methodology does not have ability to estimate precision or accuracy. Spawner surveys vary depending upon water conditions.	TBD		$128,000	
93	**LOWER**	**Fund lower Green River Chinook juvenile migrant trap at Kent.**	WDFW	Need to operate a second trap in Kent to evaluate lower river contributions.	TBD		$75,000	$50,000
94	**LOWER**	**Need funding to calibrate and develop sampling regime for the Green River Chinook at the Howard Hanson fish facility.**	Army Corps of Engineers	Howard Hansen Dam fish facility is to be completed by Corps. This will provide additional migrant information.	TBD			$402,000
95	**LOWER**	**Green River Chinook Fund experimental use of acoustic sampling to determine spawner abundance in the Green river on pink salmon years.**	Muckleshoot	Pink salmon runs confound spawner survey information on odd years. Need acoustic or other method to determine differences.	TBD			

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
PUYALLUP RIVER WATERSHED								
96	**ONGOING**	**HATCHERY REFORM** **Puyallup Chinook** Puyallup River Watershed Fisheries Research Monitoring and Evaluation.	Puyallup Tribe	Primarily involves two separate elements: 1) Juvenile out-migrant monitoring at both the Electron Fore bay smolt trap and Puyallup River screw trap, and 2) Adult return monitoring throughout the Puyallup, Carbon and White Rivers as well as the Buckley Trap located on the White River.	NWIFC PCSRF	$251,500	$251,500	
97	**ONGOING**	**Puyallup River** Spawning Surveys	Puyallup Tribe	Conduct spring Chinook spawning surveys		$25,000		
98	**ONGOING**	**Puyallup River** Spawning Surveys	Puyallup Tribe	Spawning surveys data processing		$12,000		
99	**ONGOING**	**Puyallup River** Buckley trap DNA and scales	Puyallup Tribe	Sample Buckley trap for DNA and scales to age upstream stocks of Chinook		$10,000		
100	**ONGOING**	**Puyallup River** Clarks Creek Hatchery CWT	Puyallup Tribe	CWT 200,000 summer/fall Chinook		$25,000		
101	**HIGHEST**	**White River Chinook** Army Corps of Engineers should replace the Buckley trap with a functional facility.	Army Corps of Engineers	White River Buckley trap is operated by ACE and is barrier to fish passage. It needs to be rebuilt as it kills fish and does not allow for accurate enumeration and monitoring of upstream and downstream migrants.	ACE		NA	$80,000,000 (Note: this is not part of total for HIGHEST priorities)

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
102	**HIGHEST**	**White River Chinook** Fund juvenile migrant trap in the White River.	Muckleshoot	Lack of White River Chinook juvenile migrant trap precludes freshwater productivity estimates at this time.	TBD		$116,000	$70,000
103	**HIGH**	**Puyallup Chinook** Fund DIDSON evaluations for counting salmon under turbid conditions.	Puyallup Tribe	Current estimates are not as accurate as desired due to glacial turbidity and confounding effects of multiple species of salmon migrating at the same time. DIDSON sonar may be able help improve accuracy of adult estimates.	TBD		$107,000	$100,000
104	**HIGH**	**Puyallup-White Spring Chinook** Radio telemetry study of migration and timing within the river from mouth to spawning grounds.	Puyallup Tribe	Will help determine White River passage delay at Buckley and other habitat uncertainties in disparity between what is passed at the dam and what is recorded at main stem spawning areas. It will also help determine fall back rate from the dam.	TBD		$150,000	$50,000
105	**HIGH**	**White River Chinook** Fund laboratory analysis of DNA samples taken in the White River over past 10 years.	WDFW	There is a backlog of 900 White river DNA samples that can be used to better genotype white river natural Chinook.	PCSRF Hatchery Reform			$49,500
106	**LOWER**	**Puyallup Chinook** **Fund analysis of past and present methods for calculating escapements and to develop a way of adjusting past escapement estimates.**	Puyallup Tribe	Need to develop means of adjusting historical escapements.	TBD		?	?

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
NISQUALLY RIVER WATERSHED								
107	**ONGOING**	**HATCHERY REFORM** **Nisqually Chinook** Floating Weir Operation.	Nisqually Tribe	Weir installed in 2011. Needs operation money to determine operating efficiencies and debug during 5 months of Chinook migration June through October.	RCO PCSRF Project 11-1653	$380,000	$380,000	
108	**ONGOING**	**HATCHERY REFORM** **Nisqually Chinook** Determining in season run size estimates for natural spawners.	Nisqually Tribe	Need to be able to make in season adjustments in harvest based upon natural/wild escapement back to the river. This may be possible using the new weir or lower river tangle net interceptions of natural/hatchery ratios.	RCO PCSRF & NWIFC grant	$42,000	$42,000	
109	**ONGOING**	**Nisqually Weir Operations**	Nisqually Tribe	Annual operation and maintenance of new weir placed across the Nisqually River	PCSRF Hatchery Reform	$380,000	$380,000	
110	**HIGHEST**	**Nisqually Chinook** Fund a study of the degree of spawning downstream of the new Nisqually weir site and calibrate the new weir for its efficiency and fall back rate.	Nisqually Tribe & WDFW	Need to calibrate the new Nisqually River weir and develop a method for estimating spawning downstream of the weir in order to determine total spawner abundance in Nisqually. Collect DNA samples.	PSC Sentinel program		$200,000	
111	**HIGHEST**	**Nisqually Chinook** Fund the design and study of the relative reproductive fitness of spawning upstream of the new weir.	Nisqually Tribe	The new weir is designed to significantly reduce the numbers of hatchery origin Chinook that spawn naturally and allow for development of a natural locally adapted Nisqually run of Chinook. A relative reproductive fitness study should be incorporated in conjunction with the weir.	TBD		$40,000	

	RANKING	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Monitoring Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
112	**LOWER**	**Nisqually Chinook Install downstream migrant trap in lower Nisqually river.**	WDFW	Need to determine juvenile migrant production downstream of the trap site in order to estimate accurately the trend in freshwater productivity of Chinook.	TBD		$80,000	$50,000
113	**HIGHEST**	**Data Exchange Network** Implement a new data flow utilizing WDFW Chinook adult returns data sets.	WDFW	Creation of this system will involve merging several internal systems, implementing a web-based user interface for input and analysis, the creation of electronic field collection recording forms and development of web reporting services with the ability to exchange raw data and final analysis estimates with regional partners. This data capture system and data flow will be compatible with previous Exchange Network data flows for juvenile salmonid migrant trapping data. Additionally, this adult data exchange database will complement other restoration-protection project information flows or high priority data exchanges as identified in consultation with the state and federal caucuses in Puget Sound.	EPA Data Exchange Funding		$40,000	$250,000
CENTRAL-SOUTH SOUND TOTALS						**$1,197,536**	**$2,066,731**	**$1,271,500[2]**
GRAND TOTALS						**$6,229,275**	**$4,874,465**	**$2,696,260**

[2] Does not include capital projects needed by the US Army Corps of Engineers totaling 100 million dollars for fish passage improvements at Buckley Dam and Hiram Chittenden Locks

The following summary KEA scoring table for Chinook (Figure 14) reflects the impact that the funding proposals will have on VSP monitoring as a whole. As can be seen, the majority of proposals were targeting the major VSP components such as adult abundance, juvenile migrants, diversity and spatial distribution.

TRT Population	Adult spawner Abundance measured?	Ave Egg deposition determined?	Egg to fry survival calculated?	Recruits Prior to Fishing estimated?	Hatchery Fish are marked?	PHOS Measured?	Fecundity Measured?	ex ratios and age determined?	uvenile migrant Abundance & Productivity SAR?	Cohort reconstruction?	Harvest Estimates are reliable?	Marine survival measured?	uvenile FW parr or fry densities measured?	Juvenile marine nearshore densities measured?	Offshore densities are measured?	FW Spatial Distribution?	Marine nearshore spatial distribution?	Species Diversity Age, run timing, cohort structure,	Species Diversity DNA and genetic diversity	Score
Mid Hood Canal Chinook									11									7, 8, 9		
Skokomish Fall	12, 13																			
Dungeness River Chinook		18	18																20	
Elwha River Chinook		23	23		19				21							22			20	
NF Nooksack	28, 30				34	32		29	31						78				32, 34	
SF Nooksack	28, 30							29	31, 33						78					
Lower Skagit Fall Chinook	50								50						78	50			50	
Upper Skagit Summer	50								50						78	50			50	
Upper Cascade Spring	50								50						78	50			50	
Lower Sauk Summer	50, 51					52			50						78	50			50	
Upper Sauk Spring	50								50						78	50			50	
Suiattle Spring Chinook	50								50						78	50			50	
NF Stillaguamish				59	59									76, 77	78				59, 76	
SF Stillaguamish														76, 77	78				76	
Skykomish					72		74		71	79		79		73,75, 76,77	78				72	
Snoqualmie							74		70					75, 76,77	78					
Sammamish	83								83, 84						78					
Cedar	83								83,85, 86				85, 86		78	86				
Green/Duwamish	90, 92, 93								89, 91, 92						78					
Puyallup	101, 104														78	102		102		
White	99								99, 100						78	102		102	103	
Nisqually	108								110						78				109	

Figure 15. Comparison of how various funding proposals meet the gaps in Chinook KEAs.

Chum Funding Proposals

Table 14. Highest priority summer chum monitoring funding proposals

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
114	**ONGOING**		WDFW	Need summer chum otolith and DNA analysis of adults in the ESU to continue evaluation of supplementation program contributions and potential impacts. = $10,000 every 2 years.	WDFW has funding now with support from HCSEG, but it is tenuous; funding request would provide about half of total needed.	$ 5,000		
115	**ONGOING**	**DNA Analysis** Hamma Hamma and Duckabush Summer Chum Juvenile	WDFW	Need chum DNA analysis of the out migrants to determine proportion and timing of early chum and late chum; can be determined with existing DNA baseline; need funding.	WDFW, SRFB (FIFO, year to year and tenuous)	$34,000		
116	**ONGOING**	**Extend Operation of Migrant Trap** Dewatto Summer Chum from current April-May to Jan-May.	HCSEG	Screw trap in place annually for steelhead (April-May); need to trap entire summer chum outmigration timing each year (Jan-May); need funding. Trapping is not adequately funded for full extent of outmigration of all species being trapped. This will provide full estimate of migrant chum and allow for sampling early and late chum DNA, including genetic lab analysis.	HCSEG, Existing Monitoring but Funding Tenuous*.	$35,000		
117	**ONGOING**	**Summer chum spawner surveys**	WDFW	Spawner surveys provide escapement, spatial distribution, diversity, NOR/HOR estimates; and evaluation of effectiveness of	WDFW, Existing Monitoring	$72,000		

				supplementation programs				
118	**ONGOING**	**Operation of adult trap on Union River**	HCSEG	Trapping provide escapement, size, and sex ratio estimates. Site of broodstock collection for reintroduction program in Tahuya River.	HCSEG, Existing Monitoring	$10,000		
119	**ONGOING**	**Operation of adult trap on Big Beef Creek**	WDFW	Trapping provide escapement, size, and sex ratio estimates	WDFW existing monitoring	$10,000		
120	**ONGOING**	Liliwaup Broodstock sampling and otolith marking for supplementation program	WDFW	Follow spawning protocols/procedures in Recovery Plan and collect size, sex, and fecundity from broodstock at trap site and WDFW George Adams Hatchery. In order to determine NOR/HOR and evaluate effectiveness of supplementation program: calibrate chillers, apply pre-hatch and post-hatch otolith marks following otolith marking schedule provided by WDFW Otolith Lab staff, and collect reference samples.	WDFW, some existing Monitoring, but funding is tenuous	$1,000	$14,000	
121	**ONGOING**	**Union Broodstock sampling and otolith marking for supplementation program**	WDFW	Follow spawning protocols/procedures in Recovery Plan and collect size, sex, and fecundity from broodstock at trap site and WDFW George Adams Hatchery. In order to determine NOR/HOR and evaluate effectiveness of supplementation program: calibrate chillers, apply pre-hatch and post-hatch otolith marks following otolith marking schedule provided by WDFW Otolith Lab staff, and collect reference samples.	WDFW, some existing Monitoring, but funding is tenuous	$1,000	$14,000	
122	**HIGHEST**	**DNA Analysis** Tahuya Juvenile Chum	WDFW	Need DNA analysis of the summer chum out migrants to determine proportion and timing of early chum and late chum; can be determined with existing DNA baseline; need funding.	None		$17,200	

123	**HIGHEST**	**Outmigrant Summer Chum and Chinook Analysis** for all HC rivers.	WDFW	WDFW will establish a study design, analysis, and reporting of juvenile migrant abundance and survival for populations in the HC MPG. Total cost would be 6 months biologist ($30,000 per year).	None		$30,000	
124	**HIGH**	**Little Quilcene Summer Chum** Juvenile chum DNA Analysis.	WDFW	Need DNA analysis of the chum out migrants to determine proportion and timing of early chum and late chum; can be determined with existing DNA baseline; need funding.	None		$17,200	
125	**HIGH**	**Little Quilcene Summer Chum** Increase screw trap sampling period for Little Quilcene trap to include chum and steelhead Jan-March.	HCSEG	Screw trap in place annually for steelhead (April-May) on Little Quilcene; need to trap entire summer chum outmigration timing each year (Jan-May). Need DNA analysis of the out migrants to determine proportion of early chum and late chum; can be determined with existing DNA baseline; need funding. HCSEG estimates that it would cost $15,000-$20,000 to operate the Little Quilcene trap Jan-Mar. We would also need to install additional safety mechanisms to protect the trap during high flows.	Existing Monitoring		$26,500	
126	**LOWER**	**DNA Sampling Dewatto** Chum As part of chum reintroduction program evaluate 400 chum fry per year for DNA.	WDFW	In order to achieve 10% precision with 90% certainty 400 samples will need to be collected at $43/sample.	TBD		$17,200	
127	**LOWER**	**Dewatto Chum Reintroduction.**	WDFW / HCSEG	Dewatto reintroduction is pending co-manager/NMFS approval.	TBD		$4,000	
				TOTAL		**$168,000**	**$140,100**	**$0**

The following summary KEA scoring table for chum (Figure 15) reflects the impact that the funding proposals will have on VSP monitoring as a whole. As can be seen, the majority of proposals were targeting the major VSP components such as adult abundance, juvenile migrants, diversity and spatial distribution.

TRT Population	Adult Spawner Abundance	Ave Egg deposition is determined	Egg to fry survival is calculated	Recruits Prior to Fishing is estimated	Hatchery Fish are marked	PHOS is Measured	Fecundity is Measured	Sex ratios and age is determined annually	Juvenile Migrant Abundance determined	Cohorts reconstructed annually	Harvest Estimates are reliable	Marine survival is measured annually	Juvenile FW parr or fry densities measured?	uvenile nearshore densities are measured	FW Spatial Distribution is known	Marine nearshore spatial distribution is mapped	Species Diversity life history is tracked	Species Genetic Diversity measured	Score
Union River									121										
Lilliwaup									121										
Hamma Hamma									121										
Duckabush									121										
Doswallips									121										
Big & Little Quilcene									121, 123									122	
Dewatto					125	125			121									124	
Tahuya									121									120	
Anderson									121										
Big Beef									121										
Skokomish									121										
Finch									121										
Chimacum Creek									121										
Snow Creek Salmon Creek									121										
Jimmycomelately Creek									121										
Dungeness River									121										

Figure 16. Comparison of how chum funding proposals meet identified KEA gaps

VSP Steelhead Funding Proposals

The following figure (Figure 16) shows the extent of ongoing steelhead monitoring by MPG and the relative amount of funds proposed for new annual operational costs and one time equipment or set up costs

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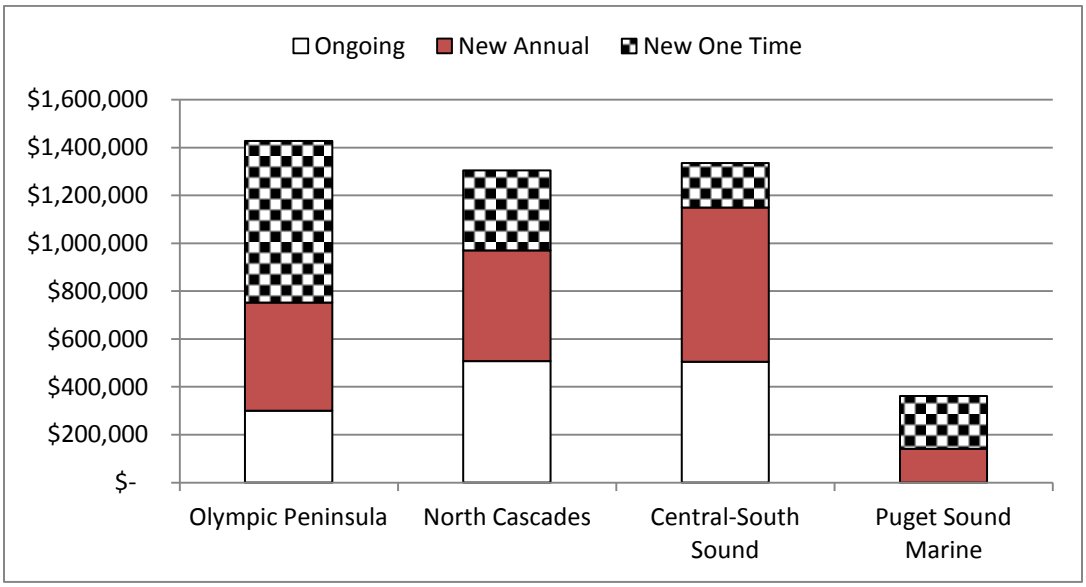

Figure 17. Steelhead ongoing and new proposed monitoring costs by MPG.

Steelhead Monitoring Strategies

Old Strategies

Historically steelhead populations were tracked by the steelhead harvest punch card which was initiated in the 1940s. This allowed managers to determine the total catch per river and to develop an idea of the migration timing and spawn timing of natural fish. This was rapidly complicated by the increased hatchery production of steelhead in the 1940s and 1950s in most of the major winter-run rivers of western Washington. Punch card information was not available until a year after the winter season due to the delay in returning and compiling punch card information. This was combined with rack counts at hatcheries, dams, and fishways to develop some idea of the strength of run size of wild versus hatchery raised steelhead.

In 1974 when the Boldt decision was rendered under U.S. versus State of Washington 50-50 allocation of harvestable steelhead forced the Department of Game and the tribes into a different management requirement for in-season determination of the weekly harvest and allocation balance between treaty tribes and state. Harvested fish, both tribal and sport caught, provided information on size, age, fecundity, run timing, sex ratios, and other information for both hatchery and wild components of the

run. In addition, spawner surveys were implemented in many rivers to enable development of agreed upon escapement goals and spawner recruit curves.

This persisted into the 1980s when concern over the status of wild steelhead by WDFW biologists led to the implementation of steelhead wild release recreational fishing programs for most western Washington Rivers. Under this new regulation, wild steelhead with an intact adipose fin had to be released when caught so that it could continue to spawn and maintain wild populations. The management goal was to maximize harvest of hatchery fish and minimize harvest impacts to wild fish. The unintended result was that it became very difficult to obtain samples of adult wild fish except in tribal net fisheries to determine the necessary information for cohort reconstructions such as age, sex ratios, etc. as detailed above. Unlike salmon, steelhead do not die after spawning so there are no carcasses available for collecting life history information. Historically in many streams re-spawning females comprised a significant proportion of the total number of female spawners (10-30%).

At the same time, information collected from WDFW research projects such as at Kalama River and Snow Creek began to point to possible genetic problems created by hatchery steelhead spawning with wild steelhead. By the 1990s some hatchery steelhead programs were being reduced and/or modified to reflect the local steelhead stock. This was also influenced by large budget reductions required by the legislature. In 2007 the listing of steelhead as threatened in Puget Sound eliminated directed harvest on wild populations and formalized concerns over hatchery impacts. The reduction in hatchery programs now presented in the 21st century reflect an overall decline in steelhead abundance coast-wide, a lack of access to adult wild steelhead due to no legal sport fishery for wild fish and an overall dearth of information on the status of wild steelhead populations.

In addition, there has been a lack of adequate downstream migrant trap data for steelhead smolts. The first smolt trapping for steelhead began in the 1970s using various fyke, inclined plane and screw traps for access to the fish. Two problems were quickly identified that persist into the present. Steelhead are much larger than Chinook or coho migrants and are very fast swimmers with the capability of avoiding traps much more effectively than salmon, and they also often overcome the trap water velocities and swim back out of the mouth of traps. The second problem is that the traps are difficult to calibrate for their efficiency because it is often difficult to trap enough steelhead to mark a percentage and release them upstream as a mark recapture sample. The use of surrogate hatchery steelhead smolts is not so satisfactory due to the size differential with most hatchery smolts greater than 200 mm while wild smolts seldom exceed 150 mm.

At the same time that access to wild steelhead was declining, geneticists transitioned from allozyme variation as measures of genetic diversity to DNA microsatellites and single nucleotide polymorphisms (SNP) to characterize genetic diversity. Many wild steelhead populations today lack adequate DNA baseline data to be able to follow any changes in genetic diversity. As a result, the Puget Sound Steelhead Technical Review Team (TRT) did not always have genetic data needed to inform decisions about demographic independence of populations or diversity impacts on wild populations from hatchery stocks.

The limited information from acoustic tagging and other tagging suggest that mortality of steelhead smolts may be high within Puget Sound, and that potential mortality levels may be correlated with travel distance to Strait of Juan de Fuca. This is a tentative conclusion and needs to be explored more thoroughly as a critical uncertainty in their life cycle. This will require dedicated and substantial funding.

A New Strategy

All of the above information was discussed with the co-managers resulting in the same recurring theme throughout Puget Sound that there is a need for a different approach to determining steelhead status and trends. A change in approach is needed that will insure non-lethal access to adult fish in the major steelhead streams of Puget Sound and will also provide better estimates of juvenile migrant numbers and marine survival.

Expansion of spawner abundance surveys Into Areas Having Little Or no Monitoring

The co-managers have proposed in this VSP review to expand monitoring for winter steelhead into the following TRT populations: Drayton Harbor (#166); upper Elwha (#154, #155), and South Sound (Chambers Creek) (#188) at a cost of $247,000.

Expansions for summer steelhead monitoring are proposed for the Tolt (#179) and SF Nooksack (#167, #168). This is estimated to cost $102,000.

Improvement of Spawner abundance and juvenile abundance estimates and smolt to adult return estimates for existing monitored watersheds

Throughout the DPS the co-managers employ different monitoring protocols and collect varying types of viability-related data at different levels of intensity and with almost universal lack of precision estimates. Annual counts of adults using a common metric (currently redd expansions) is needed and with similar methodologies in expanding counts and index areas to achieve total abundance estimates (VSP). Surveys should be conducted in both index and non-index areas in order to be able to make extrapolations. Following recommendations will also materially improve estimates.

A. The generalized random tessellated sampling (GRTS) monitoring program developed for Oregon coastal coho salmon by its TRT is recommended as a monitoring template for Puget Sound steelhead. It provides known precision, unbiased sampling, uniform protocol, ability to detect changes in spatial distribution. This recommendation is not fully supported by WDFW staff.
B. Temporary weirs and traps should be installed in major spawning tributaries of the main TRT steelhead populations where it is feasible to maintain a weir under early spring flows and yet trap spawning adults for collection of life history information, scales for aging, DNA samples, and run timing.
C. In the same tributary streams install smolt traps capable of trapping a high percentage of the stream flow where tight estimates of smolt migration can be obtained and where DNA samples and scale samples can be processed. This strategy has worked successfully for the Oregon Department of Fish and Wildlife in their so called “life cycle” streams.

D. Implement PIT tagging of steelhead parr in the same tributaries and throughout the steelhead stream in order to obtain a mark recapture estimate of parr to smolt survival rates and movements within the TRT distinct population segment.
E. Install PIT tag arrays in the tributary streams at the downstream smolt trap sites to compare total PIT tags detected to those trapped in the screw trap.
F. Abandon general index redd surveys and move to recommendation "A" above. This recommendation is not supported by WDFW staff.
G. In carefully selected locations within each MPG utilize genetic mark recapture and parentage methods to develop an alternative estimate of migrant survival and to answer some questions about the extent of anadromy in *O. mykiss* populations in Puget Sound. This recommendation is not fully supported by WDFW staff.

Some of these strategies were proposed for funding during this inventory and assessment process and should be given careful consideration. These include: using SONAR in the Dungeness to improve adult counts (#153); initiating upper Elwha spawner surveys (#154); installing 3 tributary weirs in the Elwha (#155); monitor post dam movement in the Elwha with PIT tags (#156); calibrating the Skagit juvenile screw trap and installing tributary traps for steelhead (#173); estimating for the first time SF Nooksack summer steelhead spawner abundance (#168); installing additional PIT tag arrays in the Tolt to track the summer steelhead population (#179); installing a year round video camera in the Lake Washington Chittenden fish ladder (#180); and installing a fish counter in the Nisqually at the Centralia dam (#193). The additions total $1,582,000.

This estimate does not count the large projects that need to be completed by the Army Corps of Engineers to reconstruct the Buckley trap on the White River and fish passage into Lake Washington both upstream and downstream at the Hiram Chittenden locks. Both projects are needed to reduce mortality on listed species and to improve monitoring of listed species past these facilities.

Increased genetic samples for areas of the DPS that currently have little or no baseline

Co-managers have proposed increasing baseline DNA monitoring for Nooksack WSH (#165) and SF Nooksack SSH (#167), Snohomish WSH (#176), East Kitsap streams WSH (#189), South Sound streams (#199), Puyallup WSH (#185), and Nisqually WSH (#196, #197). The improvements in DNA baselines are estimated to cost around $80,000.

Increased evaluations of relative reproductive fitness in selected hatchery programs

It is proposed to monitor the relative reproductive fitness of Green River steelhead in view of the ongoing modified hatchery programs to determine impacts (#181). Genetic assessment of resident and anadromous populations and periodic monitoring, especially to assess impacts of naturally spawning hatchery-origin steelhead is critical. Very little is known of the presence of non-migratory (resident) spawners other than precocious males. Estimates of the abundance of non-migratory adults and their contribution to anadromous progeny is needed.

Increase evaluation of marine migration patterns sources and locations of mortality in Puget Sound

Acoustic tags should be employed throughout the Sound in strategic locations using strategic populations. Tagged juveniles should be released each spring for at least four consecutive years. The objectives of this major effort would be to:

- Estimate the contribution of Puget Sound mortality to total ocean mortality of steelhead. This would require estimating Puget Sound mortality in a population or two where SAR's can be calculated at least for hatchery fish, then tag both hatchery and wild fish, which would allow for an indirect partitioning of mortality into Puget Sound vs. Ocean for wild fish).
- Identify survival bottlenecks.
- Calibrate the Juan de Fuca detection line to determine whether the reduced number of detections in past studies is a result of reduced detection capability or the result of fewer fish surviving to pass the acoustic array.
- Determine whether there are differential survival factors for specific parts of the Puget Sound.
- Identify the areas where the highest mortality rates occur and attempt to determine the causes.

In order to accomplish this, a specific design will need to be developed. Based on discussions with those involved in using acoustic tags a design scenario close to the following would be needed.

This proposal would place acoustic receivers (Vemco VR-2 $1,460) in strategic locations at the mouths of major steelhead rivers and in specific checkpoints in Puget Sound to detect acoustic tags as they passed by these checkpoints. Following are estimated number of receivers needed; and the cost of the receivers and moorage.

Table 15. Acoustic tagging supplies and estimated costs

Supplies Needed	Receivers Needed	Number On Hand	Cost
Number Of VR-2 Receivers Needed at $1,460 each	120	45	$109,500
Number of V-7 transmitter tags needed at $350 each	240	0	$84,000
Tagging Supplies including sutures	240	0	$2,400
Moorage of Receivers and placement costs at $200 per site	120	0	$24,000
Software, USB adaptor etc.	4	0	$265
Battery Replacements at $30 each	120		$360
Total estimated equipment cost			$220,525

Proposals were submitted by the Hood Canal, Skagit, and South-Central groups to monitor steelhead migration and mortality in Puget Sound (#129, #130, and #131). These were consolidated into one proposal (#128) to evaluate selected populations throughout the Sound.

The following tables reflect ongoing steelhead monitoring that the co-managers felt was important to protect and increased monitoring that was ranked either HIGHEST or HIGH in overall importance to

implement. Many of these proposals reflect the desire to move toward the new strategy outlined above and to fill critical gaps in evaluating the steelhead DPS.

Table 16. Highest Priority Steelhead monitoring funding proposals

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
PUGET SOUND DPS WIDE								
128	**HIGHEST**	**All Puget Sound Steelhead** Conduct Steelhead Marine Predation Study (1st Step, Identify location of bottlenecks).	NOAA	It is believed that significant mortality occurs on steelhead within Puget Sound and prior to passing Cape Flattery. Regarding Steelhead predation in Hood Canal, the first step would be to identify survival bottlenecks which we think are in the Admiralty inlet area. Might cost $15K for additional receivers, $60K for tags, and $30K for labor. This would add receivers to augment the POST lines and allow for finer resolution of where fish are dropping out.	None		$141,200	$220,525
129	**HIGHEST**	**All Puget Sound Steelhead** Increase acoustic sites and tags in Puget Sound 105 receivers and 240 tags throughout PS for 3 years.	NOAA	Lack of information on migration patterns and survival of wild steelhead once they leave the Skagit and other rivers and travel through Puget Sound.	None		See Line #128	See Line #128
130	**HIGHEST**	**Puget Sound All Steelhead** Need for a coordinated approach to determine mortality of steelhead in offshore areas of Puget Sound including South Sound.	Nisqually Tribe	Causes of mortality and locations of steelhead in the Puget Sound and Strait of Juan de Fuca is not known for all populations of steelhead in Puget Sound.	NOAA		See Line #128	See Line #128

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
131	**LOWER**	**Install Acoustic Tag Array Talla Point for** Hood Canal steelhead.	Port Gamble S'Klallam Tribe	Survival of Hood Canal Salmonids through Hood Canal is not understood and is critical uncertainty. Installation of acoustic site would assist in estimating survival rates. This a onetime cost. (Note: Acoustic array already installed at bridge and in Strait of Juan de Fuca. This provides another line of receivers at the entrance to the Canal. Could also include newer receivers for smaller transmitters).	TBD		See Line #128	See Line #128
OLYMPIC –STEELHEAD MAJOR POPULATION GROUP								
HOOD CANAL STREAMS								
132	**ONGOING**	**East and West Hood Canal Steelhead** Parr sampling for life history diversity.	NOAA	Currently about half of the $24k needed for parr sampling is funded. The rest is needed to assess competition between wild and hatchery fish (i.e., between hatchery residuals and natural parr). (resident/anadromous, age structure, size-at-age, competition between wild and hatchery steelhead) = $12K/year.	NOAA, Existing Monitoring but partially funded	$ 12,000		
133	**ONGOING**	**West Hood Canal Steelhead** Conduct annual steelhead spawner surveys in the Little Quilcene river.	LLTK	Steelhead spawner surveys provide escapement, spatial distribution, and genetic diversity info, inc. hatchery/natural components = $5,000/year, LLTK.	LLTK, Existing Monitoring but funding is tenuous.* Indirectly funded year-	$5,000		

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
					to-year via highly unstable funding sources			
134	**ONGOING**	**West Hood Canal Steelhead** Conduct annual steelhead spawner surveys in the Little Quilcene, Dosewallips, and Duckabush rivers.	WDFW	Spawner surveys provide escapement, spatial distribution, and genetic diversity info, inc. hatchery/natural components = $24,000/year, WDFW	WDFW, Existing Monitoring	$24,000		
135	**ONGOING**	**East Hood Canal Steelhead** Obtain Dewatto WSH juvenile steelhead out migrant data collection April-June.	NOAA	No formal escapement goals have been determined for Dewatto River steelhead. Establish escapement objectives based on steelhead productivity and productive capacity under current habitat conditions.	NOAA, Existing Monitoring	$3,000		
136	**ONGOING**	**East Hood Canal Steelhead** Conduct Dewatto Steelhead Spawner Surveys.	HCSEG	Spawner surveys provide escapement, spatial distribution, and genetic diversity info, inc. hatchery/natural components.	HCSEG, Existing Monitoring but Funding Tenuous*.	$4,500		
137	**ONGOING**	**East Hood Canal Steelhead** Conduct Dewatto Steelhead Spawner Surveys.	WDFW	Spawner surveys provide escapement, spatial distribution, and genetic diversity info, inc. hatchery/natural components = $8,000/year, WDFW	WDFW, Existing Monitoring.	$8,000		

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
138	**ONGOING**	**East Hood Canal Steelhead** Dewatto Steelhead Parr Sampling.	HCSEG	For life history diversity (resident/anadromous, age structure, size-at-age, wild/hat comp).	HCSEG, Existing Monitoring but Funding Tenuous*.	$3,500		
139	**ONGOING**	**West and East Hood Canal Steelhead** Steelhead Juvenile Migrant DNA Analysis.	NOAA	Monitoring genetic diversity in Hood Canal steelhead provides a critical metric for natural population viability and for determining the effects of supplementation on natural populations. Pre-supplementation data have been collected and analyzed. Genetic monitoring needs to continue through the supplementation and post-supplementation phases. $30k for all six streams.	NOAA, Existing Monitoring but funding is tenuous with some activities covered on a year-to-year basis by indirect sources	$30,000		
140	**ONGOING**	**West Hood Canal Steelhead** Conduct annual Duckabush steelhead spawner surveys.	LLTK	Spawner surveys provide escapement, spatial distribution, and genetic diversity info, inc. hatchery/natural components.	LLTK, Existing Monitoring, only partial funding via USFS Title II in 2012 (12k) and 2013(9k). No funding after 2013.	$20,000		
141	**ONGOING**	**West Hood Canal Steelhead** Sample Duckabush Steelhead Parr.	LLTK	Parr sampling for life-history diversity (resident/anadromous, age structure, size-at-age, wild/hat comp).	LLTK, Existing Monitoring, partially funded in 2012 ($1,500) by USFS Title II. No funding after 2012	$3,500		

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
142	**ONGOING**	**West Hood Canal Steelhead** Conduct Hamma Hamma Spawner surveys.	LLTK	Provides estimate of number of adult steelhead spawners in Hamma Hamma. (Escapement, spatial distribution, diversity, hat/wild, etc).	LLTK, Existing Monitoring but funding is tenuous.* Indirectly funded year-to-year via highly unstable funding sources	$10,000		
143	**ONGOING**	**South Hood Canal Steelhead** Steelhead Spawner Surveys - Tahuya and Union rivers	WDFW	Spawner surveys provide escapement, spatial distribution, and genetic diversity info, inc. hatchery/natural components = $16,000/year, WDFW	WDFW, Existing Monitoring.	$16,000		
144	**ONGOING**	**Skokomish Steelhead** Mainstem and North Fork Spawner survey (escapement, spatial distribution, diversity, hat/wild, etc)	WDFW	Provides estimate of number of adult steelhead spawners in Mainstem and North Fork Skokomish.	WDFW, Existing Monitoring *	$20,000		
145	**ONGOING**	**HATCHERY REFORM** **SF Skokomish Winter Steelhead** Steelhead Snorkel, hook and line surveys.	Skokomish Tribe AND NOAA	Hat/Wild and age composition (snorkel surveys, adult hook and line, etc) = $71,614.40/yr, Skokomish Tribe AND $9,000/NOAA (inc. scale analysis and 1 temp contractor).	Skokomish tribe (PCSRF) existing monitoring in fy2010 still working on funding for fy2011	$80,614		
146	**ONGOING**	**SF Skokomish Winter Steelhead** Steelhead Spawner survey (escapement, spatial distribution, diversity, hat/wild, etc).	NOAA AND Skokomish Tribe	Provides estimate of number of adult steelhead spawners in SF Skokomish. $20,000/year, NOAA and $16,526.40/year, Skokomish Tribe.	Skokomish Tribe (PCSRF), NOAA, Existing Monitoring but funding is tenuous.*	$36,526		

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
147	**ONGOING**	**SF Skokomish Winter Steelhead** Juvenile Migrant Trap and Data Collection.	Skokomish tribe AND NOAA	Lack of data on juvenile migrant production in the Skokomish River and tributaries = $17353.72/year Skokomish Tribe and $3,000/year NOAA.	Skokomish Tribe, NOAA, Existing Monitoring but funding is tenuous.*	$20,353		
148	**ONGOING**	**Skokomish Steelhead** Parr Sampling.	Skokomish Tribe & NOAA	Parr sampling for life history diversity (resident/anadromous, age structure, size-at-age, wild/hat comp) = $1,800year, Skokomish Tribe AND $1,800/year NOAA.	NOAA and Skokomish Tribe (PCSRF), Existing Monitoring but funding is tenuous.*	$3,600		
149	**HIGHEST**	**East Hood Canal Winter Steelhead** Dewatto Steelhead Snorkel and Hook and Line Sampling.	HCSEG	Lack of data for adult steelhead due to absence of weirs and harvest interceptions. Snorkeling and hook and line sampling will provide PHOS and life history information such as age structure, length, DNA, sex ratios.	None			$17,200
150	**HIGHEST**	**West Hood Canal Winter Steelhead** Duckabush Snorkel, hook and line surveys (hat/wild and age comp).	LLTK	hat/wild and age comp. Provides information on proportion of supplemented versus natural origin spawners, abundance, age composition, etc.	Not funded, period existing but not in full swing		$3,500	
151	**LOWER**	**West Hood Canal Steelhead** Stray Analysis (Quilcene River snorkel and hook and line sampling of adult steelhead).	LLTK	Evaluate level of straying that occurs into Hood Canal Steelhead Project control streams. Stray Analysis (Snorkel Survey or Adult Hook and Line) = $2,000, LLTK.				$2,000

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
152	**LOWER**	**South Hood Canal Steelhead** **S**tray Analysis (Tahuya River Snorkel Survey or Adult Hook and Line).	HCSEG	Evaluate level of straying that occurs into Hood Canal Steelhead Project control streams.	TBD			$2,000
JUAN DE FUCA STREAMS								
153	**HIGHEST**	**Dungeness Winter Steelhead** Install SONAR adult counter Dungeness steelhead.	TBD	Need for accurate adult escapement numbers. Near the mouth coupled with foot surveys.	TBD		$75,000	$100,000
154	**HIGHEST**	**Elwha Winter Steelhead** Design and implement Elwha Steelhead spawning ground surveys.	TBD	Evaluate Elwha hatchery supplementation program. Equip all late run supplemented fish with location specific tags that will allow for options for monitoring success of distribution and release locations.	TBD		$37,000	
155	**HIGH**	**Elwha Winter Steelhead** Monitor the post dam removal movement of juvenile steelhead throughout the Elwha system.	TBD	Use PIT tags and possibly radio tags to track the movement of juveniles in the system	TBD		$150,000	
156	**HIGH**	**Elwha Winter Steelhead** Install 3 additional steelhead Elwha Floating Weirs.	TBD	Needed for information on species diversity and spatial distribution and abundance. Need for additional tributary floating weirs in 2-3 locations to obtain data on adults in terms of timing, genetics, life	TBD			$525,000

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
				history and mark recapture $175K/year				
157	**HIGH**	**Elwha Winter Steelhead Genetic Analysis**	LEKT	Conduct genetic analysis of juveniles and adult migrants post dam removal	TBD		$5,760	
158	**HIGH**	**Elwha Steelhead Captive Brood Program**	LEKT	Operate and maintain a steelhead captive broodstock program at the Elwha Hatchery	TBD		$180,000	
159	**LOWER**	**Straits Independent steelhead** Design and implement adult abundance estimates		Proposed Project for improving spawner abundance redd surveys estimated cost is $30K/yr. either through total census of spawning area or probabilistic approach to develop full spawner estimates.	TBD			$30,000
OLYMPIC MPG SUBTOTALS						**$300,593**	**$451,260**	**$676,200**

NORTH CASCADE STEELHEAD MAJOR POPULATION GROUP

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
NOOKSACK-SAMISH WATERSHEDS								
160	**ONGOING**	**Nooksack Steelhead** Spawner Surveys Analysis.	WDFW, Nooksack tribe, and Lummi Nation	Ongoing analysis of spawning survey methodology is designed to improve current estimates. Evaluation of other methods could also be attempted that would lead to certainty estimates.	Dingell Johnson - Wallup Breaux	$ 80,000		
161	**ONGOING**	**Samish Winter Steelhead** Determine stock origins of Samish River steelhead.	Lummi Nation	Hatchery fish are released into Lummi Bay and targeted fishery is assumed to take mostly hatchery origin fish. Determine whether either natural stocks or locations of hatchery stocks using otoliths, DNA, and CWT analysis to determine hatchery fish contribution to Lummi tribal fishery.	SRFB #10-1943	$94,199		
162	**ONGOING**	**Samish Winter Steelhead** Comprehensive evaluation of Samish winter steelhead escapements.	WDFW	Need capability of accessing adult steelhead at weir or trap for life history information. Based on DJ-WB funds and is the highest risk for reduction in funds.	Dingell Johnson - Wallup Breaux	$20,000		
163	**ONGOING**	**Samish Winter Steelhead** Annual spawner Surveys for Steelhead.	WDFW	Escapement estimates based on cumulative redd counts in index section in the main stem Samish and in Friday Creek with expansions made for non index areas. Expansions not based on early baseline count but based on index reaches. More complete surveys being done 2011 to establish entire estimates. Then indexes can be expanded proportionally to	Dingell Johnson - Wallup Breaux	$31,766		

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
				create entire estimates.				
164	**ONGOING**	**Nooksack Steelhead** Annual spawner Surveys for Steelhead.	WDFW, Lummi Nation, and Nooksack Tribe	Redd surveys at 7-10 day intervals of the heavily used tributaries and expansions to other tributaries from 2010 base year when all steelhead tributaries were surveyed. All expanded redd counts are assumed to have 1.62 fish per redd. The forks and mainstem surveys are by aerial flights, with expansions for non-surveyed periods (after snowmelt prevents counts), from side channel foot surveys which occur for the entire period."	Dingell Johnson - Wallup Breaux	$69,974		
165	**HIGHEST**	**Nooksack Steelhead** Obtain DNA samples from adult steelhead via hook and line $8,000/sample year.	TBD	Some DNA data available. Samples collected from incidentals in fisheries. Some population baseline data available, but most from juveniles.	TBD			$8,000
166	**HIGH**	**Drayton Winter Steelhead** **Obtain spawner survey information for Drayton Harbor Dakota Creek**	WDFW	Need to develop consistent adult spawner surveys for this TRT identified population. Currently on a spot check basis	TBD		$15,000	$25,000

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
167	**HIGH**	**SF Nooksack Summer Steelhead.** DNA analysis for baseline. Fund running S Fork summer run tissues on hand.	TBD	Allozyme analysis of South Fork Nooksack summer steelhead showed them to be very different from other Nooksack and north Puget Sound steelhead stocks (Phelps et al. 1997). $2,000/sample year	None			$3,500
168	**HIGH**	**SF Nooksack Summer Steelhead** spawner abundance	Nooksack Tribe	There are no abundance data for South Fork Nooksack summer steelhead. Some steelhead observed during Chinook surveys and snorkel counts that provide some information.	None		$20,000	
SKAGIT WATERSHED								
169	**ONGOING**	**Skagit Steelhead Spawning Ground Surveys**	Upper Skagit tribe	Conduct surveys, process data, age scales and analyze data. Upper Skagit contribution 14%		$5,000		
170	**ONGOING**	**Skagit Steelhead Sampling in the commercial and test fisheries**	Upper Skagit tribe	Evaluate and process steelhead data from incidental catches		$5,000		
171	**ONGOING**	**Skagit Steelhead Steelhead scale processing**	Upper Skagit tribe	Process scales and operate smolt trap on the Skagit		$21,000		
172	**ONGOING**	**Skagit Steelhead Operate three tributary smolt traps**	Upper Skagit tribe	Currently 3 traps grant funded through EPA/PSP	EPA/PSP	$180,000		

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
173	**HIGHEST**	**Skagit Winter Steelhead** Calibrate Skagit trap for Steelhead by installing 3 tributary traps and marking with PIT tags.	WDFW & Upper Skagit	Juvenile trap is not calibrated for steelhead so no estimates of outmigration can be made. Proposal is to install another migrant trap in an upstream tributary and mark fish before releasing downstream.	PSP One year 2012		$170,000	$70,000
STILLAGUAMISH RIVER WATERSHED								
174	**LOWER**	**Deer Creek Summer Steelhead** Improve Monitoring of by installing migrant trap, PIT tag array and PIT Tagging juveniles.	WDFW	(1)Need strong analysis of migrant trap catchability for steelhead. (2)Will use PIT tags and arrays to develop estimates of juvenile migrant abundance and adult abundance. (3) Use hydro-acoustic tags to track Stillaguamish fish through Puget Sound. 10,000 PIT Tags.	TBD		$85,000	$50,000
175	**LOWER**	**Stillaguamish Winter Steelhead** Increase Stillaguamish steelhead spawner surveys.	WDFW	Lack of consistent adult spawner surveys. Accuracy and precision of Stillaguamish winter steelhead should be improved.	TBD		$10,000	
SNOHOMISH RIVER WATERSHED								
176	**HIGHEST**	**Snohomish Winter Steelhead** Collect steelhead DNA samples from all areas of Snohomish system.	WDFW	Collect DNA Samples from all parts of the watershed for baseline but especially the Snoqualmie system where there is an ongoing hatchery steelhead segregated program $30K.	TBD			$30,000

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
177	**HIGH**	**Snohomish Winter Steelhead** Collect Scales for cohort analysis.	WDFW	Collect scales to update age and sex ratio information. (2) Sample population for PHOS estimate. (3) Develop phenotypic and genetic monitoring and sampling plan. Develop methods to collect origin, age, length and sex ratio data.	TBD			$48,000
178	**HIGH**	**Snoqualmie Winter Steelhead** Develop study of Snoqualmie river hatchery steelhead smolt interactions.	WDFW	Concern over interactions with hatchery steelhead smolts and interactions with juvenile salmon and steelhead.	TBD		$87,000	
179	**HIGH**	**Tolt Summer Steelhead** Add pit tag antennae array site smolt trap downstream of forks to capture summer steelhead movement in the Tolt system.	WDFW	PIT tag array is useful for determining movement and survival rate of steelhead parr in Tolt. Use of a migrant trap in the Tolt would allow for mark recapture estimates of total migrants leaving Tolt system. Also expand snorkel surveys to once a month would again maintain timing of adult movement. There is also a suggestion to include a smolt trap in the main stem Tolt.	TBD		$76,000	$100,000
NORTH CASCADE MPG SUBTOTAL						**$506,939**	**$463,000**	**$334,500**
SOUTH-CENTRAL SOUND STEELHEAD MAJOR POPULATION GROUP								

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
LAKE WASHINGTON – CEDAR WATERSHED								
180	**HIGHEST**	**Lake Washington Steelhead** Fund year round steelhead video counts in the Hiram locks fishway.	ACE & WDFW	Lack of information on passage of adult steelhead upstream into the Lake Washington system.	TBD		$20,000	$80,000
GREEN RIVER WATERSHED								
181	**HIGHEST**	**Green River Steelhead** Fund a study of the relative reproductive success of integrated Green River steelhead hatchery stock program.	WDFW & Muckleshoot	The Green River integrated hatchery steelhead program is assumed to be improving survival and adaptation to the Green River. However, there is no study underway to track the responses of the naturally produced steelhead to the changes in the hatchery program. This would fund a comparison of interactions & outcomes with wild-born steelhead with the integrated hatchery stock adults on spawning grounds.	TBD		$80,000	
PUYALLUP RIVER WATERSHED								

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
182	**ONGOING**	**Puyallup Steelhead** **Buckley Trap**	Puyallup Tribe	Collect scales and DNA at Buckley trap	TBD	$10,000		
183	**ONGOING**	**Puyallup Steelhead** **Blank Wire CWT marking**	Puyallup Tribe	Mark steelhead with blank CWT for detection	TBD	$10,000		
184	**ONGOING**	**Puyallup Steelhead** **Spawning Surveys**	Puyallup Tribe	Conduct spawning ground surveys for Puyallup steelhead	TBD	$25,000		
185	**HIGH**	**Puyallup Steelhead** Funding is needed for analysis of DNA samples on backlog.	Puyallup Tribe	DNA samples for steelhead are needed to firm the baseline characteristics of Puyallup River natural steelhead. This is necessary to accurately determine trends in genetic diversity within the population.	TBD		$5,000	
186	**LOWER**	**Puyallup River Steelhead** Fund a study to determine the extent of resident rainbow trout in the population and its impact on steelhead.		Resident rainbow trout are observed in the Puyallup and carbon Rivers but their contribution to the overall abundance of O. mykiss in the watershed is not known. If it is significant it can alter the estimates of steelhead productivity in the watershed.	TBD			

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
187	**LOWER**	**Puyallup River Steelhead Mainstem smolt trap operation**	Puyallup Tribe	Operate smolt trap at Electron Dam	TBD		$85,000	
188	**LOWER**	**Chambers Creek Steelhead** Fund evaluation of current spawner abundance for natural populations.	WDFW and Nisqually tribe	No ongoing monitoring.	TBD		$20,000	
EAST KITSAP POPULATIONS								
189	**HIGHEST**	**East Kitsap Steelhead** Fund collection and analysis of DNA samples from juvenile migrant steelhead taken in migrant traps.	Suquamish Tribe & WDFW	There is little known about the genetic diversity of steelhead in East Kitsap streams. Adults are seldom collected, but traps designed to enumerate other species sometimes catch steelhead migrants. Need DNA samples from migrants from East Kitsap streams.	TBD		$5,000	
190	**LOWER**	**East Kitsap Steelhead** Nearshore steelhead abundance data needs to be published and available for analysis.	Suquamish Tribe	Some recent studies of nearshore area along east Kitsap shoreline have been completed but data are not available. Nearshore data needs to be published and available for analysis.	TBD			
NISQUALLY RIVER WATERSHED								

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
191	**ONGOING**	**Nisqually Steelhead** **Smolt trap operation**	Nisqually Tribe	Operate rotary screen smolt trap for WDFW	TBD	$250,000		
192	**ONGOING**	**Nisqually Steelhead** **Estuary Monitoring**	Nisqually Tribe	Monitor presence and behavior of Chinook and steelhead in the estuary and near shore	TBD	$150,000		
193	**HIGHEST**	**Nisqually steelhead** Fund fish counter in Centralia diversion dam.	WDFW and Nisqually tribe	Need for installing fish counter in Centralia Diversion Dam to count up river escapement.	TBD			$75,000
194	**HIGHEST**	**Nisqually steelhead** Develop and conduct standardized approach to counting steelhead abundance in the Nisqually river and tributaries.	WDFW and Nisqually tribe	Need to improve steelhead Nisqually steelhead abundance estimate and settle which tributaries will be included in overall estimate.	WDFW GFS and DJ-Wallup-Breaux. Nisqually Tribe funding through BIA funds.		$150,000	$30,000
195	**HIGHEST**	**Nisqually Steelhead** **Captive Brood Program**	Nisqually Tribe	Low numbers of steelhead may indicate the need for a captive brood program to safeguard their status	TBD	`	$250,000	

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
196	**HIGH**	**Nisqually Steelhead** Fund analysis of backlog of steelhead DNA tissue samples.	WDFW and Nisqually tribe	The baseline for natural steelhead genetic diversity is at present tentative. There is a need for analysis of backlog of DNA tissue samples in order to make more definitive evaluations of Nisqually steelhead phylogeny and diversity.	TBD		$20,000	
197	**HIGH**	**Nisqually Steelhead** Develop a strategic DNA collection regime tied to the weir, smolt trap, and tributary sampling.	WDFW and Nisqually tribe	The baseline for natural steelhead genetic diversity is at present tentative. Current collections have been developed on an ad hoc basis. A well designed DNA collection procedure is needed.	TBD		$5,000	
SOUTH SOUND STEELHEAD POPULATIONS								
198	**ONGOING**	**South Sound Steelhead MPG** Continue downstream migrant trapping at Deschutes River and several South Sound streams.	Squaxin Island Tribe and WDFW	Funding for long term downstream migrant traps is at risk.	TBD	$60,000		
199	**HIGHEST**	**South Sound Steelhead MPG** Increased Adult steelhead sampling and tissue collections and DNA analysis.	WDFW , Squaxin, and Nisqually tribes	Numerous small streams with very few fish make it difficult to determine status/trend of this population. Systematic approach is needed to do a probabilistic sampling of historically occupied areas of South Sound.	TBD		$5,000	
CENTRAL –SOUTH SOUND SUBTOTAL						**$505,000**	**$645,000**	**$185,000**

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE	Ongoing Annual Operational Costs	Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
GRAND TOTAL PUGET SOUND STEELHEAD DPS						**$1,312,532**	**$1,700,460**	**$1,416,225**

The following summary KEA scoring table for steelhead (Figure 17) reflects the impact that the funding proposals will have on VSP monitoring as a whole. As can be seen, the majority of proposals were targeting the major VSP components such as adult abundance, juvenile migrants, diversity and spatial distribution.

TRT Steelhead Population	Adult Spawner Abundance	Ave Egg deposition is determined	Egg to fry survival is calculated	Recruits Prior to Fishing is estimated	Hatchery Fish are marked	PHOS is Measured	Fecundity is Measured	Sex ratios and age is determined annually	Juvenile Migrant Abundance determined	Cohorts reconstructed annually	Harvest Estimates are reliable	Marine survival is measured annually	Juvenile FW parr or fry densities measured?	uvenile nearshore densities are measured	Offshore densities are measured periodically	FW Spatial Distribution is known	Marine nearshore spatial distribution is mapped	Species Diversity life history is tracked	Species Genetic Diversity measured	Score
Drayton Harbor WSH	164																126			
Nooksack WSW																	126		163	
SF Nooksack SSH	166																126		165	
Samish WSH																	126			
Skagit WSH/SSH									171								126			
Nookachamps Cr WSH																	126			
Baker WSH/SSH																	126			
Sauk SSH/WSH									171								126			
Stillaguamish Deer Cr SSH									172								126			
Stillaguamish WSH	173																126			
Stillaguamish Canyon Cr SSH																	126			
Snohomish/ Skykomish WSH										176							126		174	
Pilchuck WSH																	126			
Snoqualmie WSH																	126	175	175	
NF Skykomish SSH																	126			
Tolt SSH													177			177	126			
N Lk Washington Sammamish WSH	178																126			
Cedar WSH																	126			
Green WSH						179											126		179	
Puyallup-Carbon WSH									185								126	184	183	
White WSH																	126			
Nisqually WSH	191, 192				193	193											126	193	193, 194, 195	
South Sound WSH	197																126		197	
East Kitsap WSH														188			126		187	
Olympic W. Hood Canal WSH	148, 149																126			
Skokomish WSH																	126			
E. Hood Canal WSH	147																126			
S. Hood Canal WSH	150																126			
Juan de Fuca Lowland Tributaries WSH																	126			
Dungeness WSH	151																126			
Elwha WSH	152				156	156										153, 154	126	154	155	
Straits Independent WSH	157																126			

Figure 18. Comparison of how funding proposals meet the KEA identified gaps for steelhead populations.

OTHER HATCHERY OPERATIONAL AND CAPITAL FUNDING NEEDS

Although this report does not address the funding needs to operate or maintain hatcheries or to implement hatchery refitting and reform to address Hatchery Genetic Management Plans (HGMP) under the ESA and the recommendations of the Hatchery Scientific Review Group (HSRG), some of their funding needs are captured in the table below but not considered directly related to VSP monitoring.

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE		Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
	North Sound	**HIGHEST Harvey & NF Hatchery Facilities Retrofits For VSP programs**	Stillaguamish Tribe	Retrofits include: UV treatment/filtration at Harvey and NF; new incubation well at NF; pollution pond baffles at Harvey; Windows for natural lighting at NF;	NEW		$0	$364,000
	North Sound	**Reconfigure Marblemount Hatchery**	Upper Skagit Tribe	Improve fish passage and decrease hatchery straying by modifying hatchery structures	TBD			$525,000
	North Sound	**Marblemount Hatchery CWT Readers**	Upper Skagit Tribe	Purchase CWT readers 1 Heiloscope high resolution LCD video zoom microscope and 8 inch viewable monitors	TBD			$2,600
	North Sound	**Marblemount Hatchery Construct CWT Room**	Upper Skagit Tribe	Construct an equipment room for extracting CWTs and reading and also aging scales.	TBD			$30,000

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE		Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
	North Sound	**HIGHEST Tulalip Hatchery effluent Monitoring**	Tulalip Tribes	Hatchery Effluent Pollution Monitoring: Unfunded mandate ongoing annually with no external funding, 1/4 FTE sampler/lab tech, all sample collection, analysis and flow monitoring for 3 separately permitted facilities (see budget)	Not Funded		$37,430	
	North Sound	**HIGHEST Tulalip Hatchery Bacterial Kidney Disease Monitoring**	Tulalip Tribes	Monitor the effects of mass marking on BKD. Not funded but needs periodic funding when disease and fish losses occur, includes minimal salaries, small subcontract for fish disease assays, supplies, fringe and indirect	NEW Not Funded		$12,941	
	North Sound	**HIGH Tulalip Hatchery Study of hatchery Coho smoltification mortality**	Tulalip Tribes	Study juvenile coho smoltification-related mortality problem at Tulalip Hatchery. Total shown is total estimated to conduct periodic, opportunistic studies of an unexplained, annual, seasonal die off in juvenile Coho and Chinook differentially affecting larger, silvery parr & fingerlings (controlled trials of symptomatic/non-symptomatic fish, salt substitution, physiological testing, etc)	TBD		$ 30,000	
	North Sound	**LOWER Tulalip Hatchery Electronic Fish Counters**	Tulalip Tribes	Acquire electronic fish counter tunnels to enumerate Tulalip chum releases. Unfunded. Smith-Root quote, no funds requested to operate annually to get accurate release counts. Utilizes existing brain box, requires specific counting tunnels and placement for Chum enumeration.	TBD			$14,000
	North Sound	**LOWER Tulalip Hatchery Chinook Imprinting Study**	Tulalip Tribes	Imprinting study to further reduce straying.	TBD			$300,000

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE		Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
	North Sound	**LOWER Tulalip Hatchery Marking Trailer Maintenance and otolith thermal marking**	Tulalip Tribes	Mass marking improvements: Rewiring for marking trailer adipose fin mass marking and purchase and replacement of chillers for otolith thermal marking of all (100%) Tulalip hatchery production (all species). Based on hard quote. Needed immediately to replace failing old chillers with industrial chillers that last 30 years,	TBD			$169,000
	North Sound	**LOWER Tulalip Hatchery MSCL incubation and otolith marking O&M**	Tulalip Tribes	Improve efficiency of incubation and otolith marking facilities: This is the remaining portion unfunded to 6 small improvement projects in two incubation buildings: incubators, head boxes, chilling systems, plumbing	TBD			$185,000
	North Sound	**LOWER Tulalip Hatchery Electronic Egg Sorter**	Tulalip Tribes	Purchase electronic egg sorter/counter: Unfunded. Hard quote	TBD			$4,500
	North Sound	**LOWER Tulalip Hatchery Sediment Removal**	Tulalip Tribes	Remove sediment and waste from west fork Tulalip Creek intake reservoir: hard quote from contractor, lowest bid TERO process	TBD			$148,518
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT Construct 2 rearing ponds**	Tulalip Tribes	Build 2 large concrete rearing ponds at Tulalip Hatchery: improve water quality for environmental compliance, reduce rearing density, needed for mass marking, improved survival, reduced flow: Hard quote is $530K per pond based on one recently constructed for that amount	TBD			$1,060,000

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE		Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
	North Sound	**LOWER Tulalip Hatchery Fish Pump and counter**	Tulalip Tribes	Purchase juvenile fish pump and electronic counter	TBD			$73,000
	North Sound	**LOWER Tulalip Hatchery Lab Equipment**	Tulalip Tribes	Stock Assessment Laboratory micrograph: Fish scale and starch gel photography lighting. Unfunded. Hard quote	TBD			$4,500
	North Sound	**LOWER Tulalip Hatchery CWT readers**	Tulalip Tribes	Purchase CWT Reading Equipment: 2 Heiloscope high resolution LCD video zoom microscopes and 8" viewable monitors; http://www.engineeringlab.com/lcd-microscopes.html) @ $2,595 ea				$5,190
	North Sound	**LOWER Tulalip Hatchery CWT extraction room**	Tulalip Tribes	Construct and equip room for CWT extraction and reading at TSAL. Unfunded.	TBD			$62,000
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT Laying Pipe**	Tulalip Tribes	Trenching and installation of 1,000 feet of 8" ductile iron pipe from Utility's water tower to new well ponds. Partially funded, this is the unfunded amount.	TBD			$75,000

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE		Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
	North Sound	**LOWER Tulalip Hatchery Water monitoring and Wiring**	Tulalip Tribes	Monitor water use to hatchery: Build vault, install flow meter and transducers on pipes from 4 Utility wells to well storage ponds, wire to monitoring system for remote well operation, determine optimal pumping regime for Wells, determine hydraulic connectivity between east fork Tulalip Creek and Utility's wells and develop sustainable pumping regime. Unfunded. Estimate is for subcontract with two hydrologists over three year monitoring plan.	TBD			$75,000
	North Sound	**LOWER Tulalip Hatchery Well Water treatment tower**	Tulalip Tribes	Build packed column oxygenation degassing tower for new hatchery well and 4 Utility's wells. Partially funded, this is the unfunded amount	TBD			$15,000
	North Sound	**LOWER Tulalip Hatchery Improvements to chum holding pond**	Tulalip Tribes	Improvements to adult Chum holding ponds. Unfunded, TERO contractor quote.	TBD			$118,000
	North Sound	**LOWER Tulalip Hatchery Chum incubation maintenance**	Tulalip Tribes	Replace Chum incubation baskets, hatching screens and covers. Partially funded, TERO contractor quote.	TBD			$33,400
	North Sound	**LOWER Tulalip Hatchery electrical line**	Tulalip Tribes	Trenching and installation of 1,000 feet of electrical line to new hatchery well including all electrical connections required. Unfunded, TERO contractor quote.	TBD			$65,000

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE		Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
	North Sound	**LOWER Tulalip Hatchery install water intake pipe**	Tulalip Tribes	Purchase and install 8" line from well storage ponds to hatchery head box	TBD			220,000
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT construct new storage pond**	Tulalip Tribes	Construct new storage pond	TBD			$360,000
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT construct new settling pond**	Tulalip Tribes	Construct new settling pond	TBD			$240,000
	North Sound	**LOWER Tulalip Hatchery rearing pond improvement**	Tulalip Tribes	Modify lower Tulalip Creek pond for juvenile and adult holding and construct water diversion structure	TBD			$122,950
	North Sound	**LOWER Tulalip Hatchery Security System**	Tulalip Tribes	Install remaining security system needed for hatchery (more cameras and alarm systems, lighting/poles) at 3 hatchery facilities	TBD			$100,672

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE		Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
	North Sound	**LOWER Tulalip Hatchery Upper pond improvement**	Tulalip Tribes	Install oxygen supplementation at upper pond	TBD			$23,000
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT Drill new wells**	Tulalip Tribes	Drill 2 new wells in deep aquifer for adequate incubation and rearing to augment flows, improve water quality, and reduce rearing densities. Unfunded. Based on contractor's estimate.	TBD			$330,000
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT Dig new pipeline Phase 1**	Tulalip Tribes	Big Water Pipeline 1: Unfunded, TERO contractor's estimate, Purchase and install (trench, rebury, all connections) 12" ductile iron pipeline from Marine Drive to Hatchery headwaters (13,200 feet @ $50/lineal foot) plus digging and repaving of county road ($80K):	TBD			$805,000
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT Dig new pipeline Phase 2**	Tulalip Tribes	Big Water Pipeline 2: Unfunded, TERO contractor's estimate, Purchase and install (trench, rebury, all connections) 16"-diameter, 5,000-foot, HDPE pipeline from hatchery headwaters to hatchery head box	TBD			$327,360
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT sand filtration Ponds**	Tulalip Tribes	Construct two 40' X 20' X 3' sand infiltration ponds: Unfunded, TERO contractor's estimate, @$26,200 ea	TBD			$53,000

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE		Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT sand filtration Ponds**	Tulalip Tribes	Construct Big Water Degassing Tower. Unfunded, TERO contractor's estimate,	TBD			$25,000
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT Incubation Building**	Tulalip Tribes	Construct 50' X 60' Incubation Building on concrete slab: Unfunded, TERO contractor's estimate, ($7,500 for foundation, $45,000 for building, $20,000 to assemble building, $72,500 for 30 full Heath stacks, $7,200 electrical, $1,800 water)	TBD			$154,000
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT Install water line**	Tulalip Tribes	Purchase and install 200' water line to incubation building. Unfunded, TERO contractor's estimate.	TBD			$12,400
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT Construct concrete ponds**	Tulalip Tribes	Construct three, 130' X 70' sloped wall concrete ponds @ $325/pond: Unfunded, TERO contractor's estimate.	TBD			$975,000
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT Construct concrete raceways**	Tulalip Tribes	Construct twelve, 75' X 4' X 3' small concrete raceways. Unfunded, TERO contractor's estimate.	TBD			$366,000

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE		Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT Construct concrete raceways**	Tulalip Tribes	Construct two 120' X 6' X 4' concrete raceways. Unfunded, TERO contractor's estimate.	TBD			$183,000
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT Construct Drain Lines**	Tulalip Tribes	Purchase and construct 350 feet of HDPE drain lines from all ponds to 170-foot, 24-inch HDPE drain line. Unfunded, TERO contractor's estimate.	TBD			$52,500
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT Construct settling tank**	Tulalip Tribes	Purchase and construct 20' diameter, 10 foot-deep offline settling tank and waste removal lines. Unfunded, TERO contractor's estimate.	TBD			$54,000
	North Sound	**LOWER Tulalip Hatchery CAPITAL PROJECT Construct water alarm system**	Tulalip Tribes	Purchase and construct new water and pond alarm and water use monitoring system for new facilities. Unfunded, TERO contractor's estimate.	TBD			$72,000
	Central South Sound	**Wilkeson Hatchery Weir**	Puyallup tribe	Install a weir at South Prairie for steelhead broodstock collection	TBD			$500,000

	MPG	Staff Priority Funding Recommendations	Monitoring Entities	MONITORING GAP OR PROBLEM ADDRESSED	PROPOSED FUND SOURCE		Additional Annual Operational Cost to Implement Recommended Monitoring	One Time additional capital or Setup Costs
	Central South Sound	**Wilkeson Hatchery CWT Blank Wire**	Puyallup tribe	Mark steelhead broodstock with CWT blank wire			$10,000	
				TOTAL			**$90,371**	**$8,304,590**

UNCERTAINTY AND CONFIDENCE

The assessment across Puget Sound of VSP methods and measures identified some areas of concern for data confidence, precision, and certainty.

Adult Abundance Measures of Variance and Confidence Intervals

As discussed under spawner abundance the majority of naturally produced salmon and steelhead spawner estimates for Puget Sound have no estimates of precision or certainty built around them. This is due to the fact that index sites and redds are used to estimate the total number of returning spawners both male and female. Standardized estimates of redd life, fish per redd, relationships of index sites to total spawning area used, proportion of hatchery fish, are based upon studies conducted in the distant past. No variance estimates are available for these metrics. No measures of observer error are recorded or measured on an ongoing basis. No standardized training is documented and available for those conducting the adult surveys. Formulas and calculations are generated by field biologists and are not compiled in a centralized location. The ramifications of adult spawner abundance error affect both estimates of the status/trends of ESA listed species and the potential for de-listing, but also affect the ability to detect changes in salmon production due to improvements in overall survival due to watershed and estuary habitat improvement projects.

Attempts have been made to improve spawner abundance estimates. The recent installation of a floating weir and DIDSON technology in the Elwha and Nisqually has the potential for significantly improving estimates and generating confidence intervals. Many of the identified gaps and funding proposals are intended to improve estimates of spawner abundance. The use of genetic mark recapture evaluations has great promise of providing estimates with known precision and accuracy.

Juvenile Migrant Abundance Measures of Variance and Confidence Intervals

Juvenile migrant traps are installed in most of the Chinook streams and many of the steelhead and chum streams. The migrant traps are operated at varying lengths of time based upon funding levels and targeted species. For most sites the co-managers desire to operate the trap during the entire outmigration period for all salmon and steelhead populations within the river being monitored. The standard approach to obtaining estimates of total migration is to calibrate the trap on a weekly basis by releasing marked fish upstream of the trap and then developing a mark recapture relationship. Over the course of trapping a variance can be developed associated with trap efficiency and overall migrant estimates. Flow, time of day, turbidity, location, species, all affect trap efficiency. Co-managers have been able to develop good estimates of Chinook age 0+ migrants with CV values within the recommended range of the NOAA Guidance. In some streams CV values are also available for Chinook age 1 and steelhead migrants but the CV values are much larger. CV values are currently available for

steelhead smolt estimates from the Dungeness River, Little Quilcene River (West Hood Canal), Big Beef Creek and Dewatto River (East Hood Canal), Tahuya River (South Hood Canal), and Nisqually River. In many streams large juveniles, especially steelhead out-migrants, are able to avoid the trap and mark recapture attempts do not utilize enough fish for good estimates to be able to calibrate the trap.

QA/QC Protocol for WDFW Ageing Laboratory and Other Critical Gaps.

The Washington Department of Fish and Wildlife, Fish Ageing Laboratory produces age and rearing history (hatchery versus wild) data on approximately 70,000- 100,000 salmonids annually, of which approximately half come from the greater Puget Sound area. These data are used by state, tribal, and federal biologists, researchers and fisheries managers in run-size forecasting and other research needs. The accuracy and precision of age and life history information are critical for run reconstruction and to identify fish of hatchery origin.

Measures of ageing accuracy from scale analysis are estimated opportunistically when paired CWT and scale samples are collected. The inability to collect known age samples from wild fish limits wild fish ageing accuracy. This has forced inferences for wild fish to the hatchery population and must assume a relationship between annuli formation in wild and hatchery fish (probably a fair assumption for ocean growth, but likely poor for freshwater rearing).

Acceptable accuracy estimates vary depending on the species and condition of the scale sample, but range from 85% to greater than 95%. Typically the greatest accuracy is recorded for fishery samples (spring and fall Chinook, coho, chum and steelhead) where little to no scale erosion has occurred, while decreased accuracies are associated with spawning ground samples and hatchery vs. wild classifications.

Precision estimates between readers have been reported from 85 to greater than 95% (depending on species of interest). However, double reads (for precision) or comparisons of known age samples (CWT for accuracy) are done infrequently and are not part of a consistent QA/QC protocol.

Other critical gaps relative to ageing salmonids in Puget Sound include: 1) creation of a centralized age database 2) documentation of the WDFW scale archive 3) Increased funding to allow for consistent QA/QC to monitor precision and accuracy of age data.

QA/QC Protocol for DNA SNP and Microsatellite Laboratory Evaluations

DNA samples from Puget Sound salmonid populations are analyzed by a variety of genetic laboratories, including those at Washington Department of Fish and Wildlife, NOAA, University of Washington, and Department of Fisheries and Oceans, Canada. Results from these analyses are conveyed back to co-managers through a variety of vehicles, including reports, publications, and by direct consultations (e.g.,

Pacific Salmon Commission's technical committees). For many salmonid species, these laboratories have coordinated efforts to design common sets of assays and protocols, and to conduct analyses to evaluate the power of the assays for genetic stock identification (GSI) applications. However at this time, none of these power analyses have been published, although the methods used for GSI have been fully vetted through the peer-reviewed literature. These methods provide confidence or credibility intervals for stock or stock-aggregate GSI estimates, such as those made for fishery harvests.

There is no published error analysis or published results of double blind tests to determine variances around the genotyping of individuals or the allele (gene) frequencies compiled per population.

Issues with Federal-State-Tribal Coordination

Spawner escapement goals have yet to be agreed upon between the co-managers for some steelhead populations within Puget Sound.

REPORTING OF DASHBOARD INDICATORS

Chinook Salmon

The reporting of the status of Chinook salmon is a complicated matter as reported in the sections of this report. Greatest obstacles to timely reporting are:

1. Inconsistent protocols and calculations from population to population based upon the circumstances in the watershed and the combination of co-managers involved in calculating and approving the estimates.
2. Delays in aging scales and otoliths from the populations and in obtaining coastwide harvest information.
3. Multiple persons calculating the abundance and cohort information from multiple jurisdictions without a central repository for the information or a plan for data exchange and flow.
4. Lack of standardized data dictionary and metadata for the calculations and databases involved.
5. Lack of a consistent vocabulary to describe the various types of measurements, metrics and indicators that are required for reporting

These problems have been a continual source of frustration for those seeking to publish roll up information for Puget Sound or the state. The Governor's Salmon Recovery Office has had a problem obtaining timely information for each of their biennial reports on the State of Salmon in Washington.

Attempts are ongoing in both the Columbia Basin and in Puget Sound to standardize the approach and some progress has been made. The Pacific Northwest Aquatic Monitoring Partnership (PNAMP) has been coordinating an effort in the Lower Columbia River to coordinate data sharing and field protocols among seven county, state and federal organizations under the Integrated Status Trends Monitoring (ISTM) project. Specific progress is being made in identifying common metrics in use both for fish abundance and habitat.

In addition, PNAMP is collaborating with the Columbia Basin Fish and Wildlife Authority and StreamNet to support the data management and sharing objectives of the Columbia River Anadromous Salmonid Monitoring Strategy. The data sharing portion of the strategy encourages sponsoring agencies and tribes to identify priority projects that will help move them towards effective internal data management structures and practices. This Coordinated Assessments project is also developing a data exchange template for the Columbia Basin which describes the data elements and their format for sharing of three VSP abundance indicators (natural origin spawner abundance, smolt to adult return, and recruits/spawner). The data exchange template development team is initially focusing on developing an exchange template that can be used to provide the data needed for the NOAA Fisheries Salmonid Population (SPS) database. Testing of the exchange template and its related flow mechanisms are

targeted for the summer of 2012. The Coordinated Assessment project will be addressing other VSP indicators as part of the extended project.

In Puget Sound, a grant from the US EPA was provided to the State of Washington and the Northwest Indian Fisheries Commission to put all Puget Sound juvenile migrant information into the USEPA sponsored Pacific Northwest Data Exchange Network. It was completed in 2011. However, the same approach remains to be taken for Puget Sound adult abundance and habitat information. A concerted effort with adequate funding will be needed to automate the reporting of adult salmon and steelhead information. A proposal is included in this report to tackle plugging Chinook adult spawner data into the Northwest Data Exchange Network. Overall data sharing in Puget Sound and in the Columbia River need to be coordinated and standardized as they build the data exchange templates for both regions of Washington state.

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PARTIAL LIST OF ACRONYMS

Acronym	Meaning
ACE	Army Corps of Engineers
AUC	Area Under the Curve
BACI	Before and After Control Impact experimental design
BA	Before and After experimental design
DIDSON	Dual Frequency Identification SONAR
DIT	Double Index Tagging
DNA	DeoxyriboNucleic Acid
DPS	Distinct Population Segment
ESU	Evolutionarily Significant Unit
Fecundity	The number of eggs per female
GPS	Global Positioning System
GSI	Genetic Stock Identification
HCSEG	Hood Canal Salmon Enhancement Group
HOR	Hatchery Origin Recruits
HOS	Hatchery Origin Spawners
HSRG	Hatchery Scientific Review Group
KEA	Key Ecological Attributes
LEKT	Lower Elwha Klallam Tribe
LLTK	Long Live The Kings
NOAA	National Oceanic and Atmospheric Administration
NOR	Natural Origin Recruits
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
NOS	Natural Origin Spawners
NWFSC	Northwest Fisheries Science Center
PIT	Positive Induction Transponder
PNOB	Proportion of Natural Origin Broodstock
PNOR	Proportion of Natural Origin Recruits
RITT	Recovery Implementation Technical Team
SONAR	Sound Navigation And Ranging
SSH	Summer run Steelhead
TAMM	Terminal Area Management Module
TBD	To Be Determined
TRT	Technical Review Team
VSP	Viable salmonid Population
WDFW	Washington Department of Fish and Wildlife
WSH	Winter run Steelhead