APPENDIX D

ISRP and ISAB Comments on Annual Reports for Fish and Wildlife Program Projects with a Research, Monitoring, and Evaluation Work Element

INDEPENDENT SCIENTIFIC ADVISORY BOARD
& INDEPENDENT SCIENTIFIC REVIEW PANEL

Critical Uncertainties

for the Columbia River Basin Fish and Wildlife Program

ISAB/ISRP 2016-1
JANUARY 29, 2016

Appendix D: ISRP and ISAB Comments on Annual Reports for Fish and Wildlife Program Projects with a Research, Monitoring, and Evaluation Work Element

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Acronyms of Fish and Wildlife Program RM&E Project Proponents

BPT	Burns Paiute Tribe	NOAA	National Oceanic and Atmospheric Administration (Fisheries)
CBFWF	Columbia Basin Fish and Wildlife Foundation	NPT	Nez Perce Tribe
CBWTP	Columbia Basin Water Transactions Program	ODFW	Oregon Department of Fish and Wildlife
CCT	Colville Confederated Tribes	OSU	Oregon State University
CD	Conservation District	PNNL	Pacific Northwest National Laboratory
CdAT	Coeur d'Alene Tribe	PSMFC	Pacific States Marine Fisheries Commission
CDFO	Canadian Department of Fisheries and Oceans	SBT	Shoshone Bannock Tribes
CIT	Cowlitz Indian Tribe	SKCT	Confederated Salish and Kootenai Tribes
CREST	Columbia River Estuary Study Taskforce	SPT	Shoshone-Paiute Tribes
CRITFC	Columbia River Inter-Tribal Fish Commission	SRSRB	Snake River Salmon Recovery Board
CSKT	Confederated Salish and Kootenai Tribes	STOI	Spokane Tribe of Indians
CTUIR	Confederated Tribes of the Umatilla Indian Reservation	SWCD	Soil and Water Conservation District
CTWSRO	Confederated Tribes of the Warm Springs Reservation of Oregon	UCSRB	Upper Columbia Salmon Recovery Board
GRMW	Grande Ronde Model Watershed	UCUT	Upper Columbia United Tribes
FPC	Fish Passage Center	UI	University of Idaho
IDFG	Idaho Department of Fish and Game	USFWS	U.S. Fish and Wildlife Service
IDWR	Idaho Department of Water Resources	USGS	U.S. Geological Survey, NW Region
IOSC	Idaho Office of Species Conservation	UW	University of Washington
KTI	Kalispel Tribe of Indians	WDFW	Washington Department of Fish and Wildlife
KTOI	KTI of Idaho	WWBWC	Walla Walla Basin Watershed Council
LCEP	Lower Columbia Estuary Partnership	YBFWRB	Yakima Basin Fish & Wildlife Recovery Board
MFWP	Montana Fish, Wildlife & Parks	YN	Yakama Nation
NFWF	National Fish and Wildlife Foundation		

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199008000	Columbia Basin Pit-Tag Information	PSMFC	Programmatic	RM and E		5	link	**29**
198712700	Smolt Monitoring by Non-Federal Entities	FPC, PSMFC	Programmatic	RM and E		5	link	**30**
199403300	Fish Passage Center	FPC, PSMFC	Programmatic	RM and E	4		link	**31**
199602000	Comparative Survival Study (CSS)	FPC, PSMFC, USFWS	Programmatic	RM and E	6	2	link	**31**
199302900	Survival Estimate for Passage through Snake and Columbia River Dams and Reservoirs	NOAA	Hydrosystem	RM and E	4	3	link	**38**
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200304100	Evaluate Delayed (Extra) Mortality Associated with Passage of Yearling Chinook Salmon through Snake River Dams	NOAA	Hydrosystem	RM and E	2		link	**41**
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198910700	Statistical Support For Salmon	UW	Programmatic	RM and E		3	link	**44**
199601900	Data Access in Real Time (DART)	UW	Hydrosystem	Data Management		3	link	**45**
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200890800	FCRPS Water Studies & Passage of Adult Salmon & Steelhead	CCT	Hydrosystem	RM and E	2		link	**49**
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200206000	Nez Perce Harvest Monitoring on Snake and Clearwater Rivers	NPT	Harvest	RM and E		2	link	**63**
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199007700	Development of Systemwide Predator Control	PSMFC	Predation	Predator Removal		4	link	**69**
200800400	Sea Lion Non-Lethal Hazing	CRITFC	Predation	RM and E		4	link	**71**
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199402600	Pacific Lamprey Research and Restoration Project	NOAA, CTUIR	Programmatic	RM and E		3	link	**79**
200830800	Willamette Falls Lamprey Escapement Estimate	CTWSRO	Programmatic	RM and E	1	1	link	**81**
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199703000	Secesh Chinook & Joseph Creek steelhead abundance monitoring	NPT	Artificial Production	RM and E		4	link	**205**
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200890500	Supplementation Projects	SBT	Artificial Production	Supplementation		1	link	**210**
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Resident Fish - Lake Roosevelt and Tributaries								
199700400	Resident Fish above Chief Joseph and Grand Coulee Dams	KTI	Hydrosystem	RM and E		2	link	**328**
199104600	Spokane Tribal Hatchery Operations and Maintenance (O&M)	ST	Artificial Production	Harvest Augmentation				**330**
199501100	Chief Joseph Kokanee Enhancement	CCT	Habitat	Restoration / Protection	1	5	link	**330**
200810900	Resident Fish Research, Monitoring and Evaluation (RM&E)	CCT	Programmatic	RM and E		2	link	**332**
198503800	Colville Hatchery Operation and Maintenance (O&M)	CCT	Artificial Production	Supplementation				**333**
199001800	Lake Roosevelt Rainbow Trout Habitat and Passage Improvement	CCT	Habitat	Restoration / Protection		4	link	**334**
199404300	Lake Roosevelt Data Collection	ST	Hydrosystem	RM and E		3	link	**335**
200811500	Lake Roosevelt Burbot Population Assessment	CCT	Programmatic	RM and E		1	link	**336**
Resident Fish - Coeur d'Alene and Spokane								
199004400	Coeur d'Alene Reservation Fisheries Habitat	CdAT	Habitat	Restoration / Protection		5	link	**338**
200103200	Coeur d'Alene Fisheries Enhancement-Hangman Creek	CdAT	Habitat	Restoration / Protection		3	link	**340**
Resident Fish – Albeni Falls								
200724600	Restoration of Bull Trout Passage at Albeni Falls Dam	KTI	Habitat	Restoration / Protection		1	link	**341**
Resident Fish – Pend Oreille								
199404700	Lake Pend Oreille Kokanee Mitigation	IDFG	Habitat	RM and E		5	link	**343**
Resident Fish - Kootenai								
198806500	Kootenai River Fishery Investigations	IDFG	Habitat	RM and E		7	link	**345**
199404900	Kootenai River Ecosystem Restoration	KTI	Habitat	RM and E		2	link	**347**
199500400	Libby Reservoir Mitigation Restoration and Research, Monitoring and Evaluation	MFWP	Habitat	Restoration / Protection		6	link	**349**
Resident Fish - Flathead								
200600800	Mainstem Columbia Amendments Research at Libby Dam	MFWP	Hydrosystem	RM and E		6	link	**351**

ID	Title	Proponent organizations	Purpose	Emphasis	# of 2006 CUs directly	# of 2006 CUs indirectly	Link to 2006 CUs	Page
199101903	Hungry Horse Mitigation Habitat Restoration and Research, Monitoring and Evaluation (RM&E)	MFWP	Habitat	Restoration / Protection		2	link	**354**
199101901	Hungry Horse Mitigation / Flathead Lake Restoration and Research, Monitoring and Evaluation (RM&E)	CSKT	Habitat	Restoration / Protection		1	link	**356**
Wildlife								
200600600	Habitat Evaluation Project	CBFWF	Habitat	RM and E		4	link	**361**
200800700	Upper Columbia United Tribes (UCUT) Monitoring and Evaluation (M&E) Program	UCUT	Habitat	RM and E		8	link	**362**
200201100	Kootenai River Operational Loss Assessment	KTI	Habitat	RM and E		3	link	**364**
200301200	Shillapoo Wildlife Mitigation	WDFW	Habitat	Restoration / Protection		3	link	**366**
199802200	Pine Creek Conservation Area	CTWSRO	Habitat	Restoration / Protection		3	link	**367**
200600300	Desert Wildlife Mitigation	WDFW	Habitat	Restoration / Protection		3	link	**368**
200600500	Asotin Creek Wildlife Mitigation	WDFW	Habitat	Restoration / Protection		3	link	**369**
199608000	Northeast Oregon Wildlife Project	NPT	Habitat	Restoration / Protection		2	link	**369**
200000900	Logan Valley Wildlife Mitigation	BPT	Habitat	Restoration / Protection		5	link	**370**
200002700	Malheur River Wildlife Mitigation	BPT	Habitat	Restoration / Protection		5	link	**372**
200103300	Hangman Creek Fish & Wildlife Restoration	CdAT	Habitat	Restoration / Protection		2	link	**373**
199206103	Albeni Falls Wildlife Mitigation-Idaho Department of Fish and Game (IDFG)	IDFG	Habitat	Restoration / Protection		1	link	**374**

Introduction and Review Process

As described in the Preface, these appendices include ISRP and ISAB member[1] evaluations of the most recent annual progress reports, submitted on or before May 2015, for 187 ongoing 2015 Fish and Wildlife Program projects that contained a research, monitoring, or evaluation (RME) work element, about half of the approximately 360 Program-funded projects.[2] The annual reports were evaluated to address the Council's question: ***Is ongoing research making progress in answering critical uncertainties in the current [2006] research plan?*** This is the first time that annual reports have been used for a broad evaluation of research results; consequently on March 4, 2015, the Council and Bonneville Power Administration sent the project proponents a message informing them of this review before most of the proponents submitted their annual reports.[3] *We emphasize that this is not a proposal review informing a funding decision.* These projects were previously reviewed by the ISRP and were approved for funding by the Council. However, our annual report evaluations should inform future annual reports and development of the next review process, especially the upcoming wildlife and RME categorical reviews.

Review effort based on types of RME projects: Although we reviewed the full set of 187 projects with an RME work element, some projects were more relevant to this uncertainties review than others. About 30 of the projects had been categorized as research. Three reviewers were typically assigned to examine each research project. The full set also included status and trend monitoring projects that contribute data to inform the Council's High Level Indicators and metrics for the Federal Columbia River Power System (FCRPS) Biological Opinion. Two reviewers were typically assigned to examine progress reports for the status and trends monitoring projects. Finally, there were progress reports for many hatchery and habitat on-the-ground implementation projects that included implementation monitoring and some other basic data collection such as in-hatchery performance or stream flow and temperature

[1] Because this portion of the review involved evaluation of projects, including projects implemented by NOAA Fisheries and Columbia Tribes, ISAB Ex Officio representatives from the Columbia River Inter-Tribal Fish Commission, NOAA Fisheries, and the Council did not participate in these evaluations or review drafts of this appendix.

[2] Although the set of 187 projects with an RME work element was sufficient for the purpose of this uncertainties review, the number of projects with an RME work element varies annually, and some projects that have an RME work element in 2016 may have not been included in this review; e.g., Willamette wildlife mitigation and habitat restoration projects.

[3] The message to project sponsors: "The Northwest Power and Conservation Council will soon begin updating the Fish and Wildlife Program's Research Plan. The Independent Science Advisory Board (ISAB) and Review Panel (ISRP) will assist in updating the critical uncertainties under research, taking into account evolving topics and reporting results of past research. The ISAB/RP will use annual reports submitted to BPA to determine the extent to which critical uncertainties have been, are being, or need to be addressed for the Fish and Wildlife Program. You are receiving this notification because you are associated with a project completing RM&E work that requires annual submission of a RM&E Technical report using Bonneville's new reporting template (see RM&E Report Template and Guidance). Based on BPA contract requirements, annual progress reports are due to Bonneville on March 15, 2015 via Pisces. Aside from submission of your annual RM&E Technical report, no more will be required of you for the research plan update process. The Council will also use the revised research plan to help develop a review process for research proposals in 2016."

measurements. In general, one reviewer was assigned to examine these. Reviewers were assigned to evaluate projects under their area of expertise or projects that they previously reviewed. These evaluations gave us a basic understanding of the full spectrum of results reported and data collected by Program projects conducting research, status and trend monitoring, and implementation monitoring. This comprehensive evaluation would not have been possible by only looking at the 30 projects categorized as research.

For our evaluations of each progress report, we used a review outline that follows the headings below.

Uncertainties addressed: When progress reports were reviewed our primary task was to evaluate research projects and ascertain to what extent they addressed the set of uncertainties in the 2006 Research Plan. At the same time, additional uncertainties beyond those found in the 2006 Research Plan were also identified. These additional uncertainties were added to the uncertainties database. (See the Process section in Part 2 of this report for a description of "Direct" and "Indirect or Potential.")

Specific comments on the progress reports: We organized our review comments to reflect the Program's criteria for prioritizing critical uncertainties and evaluating RME projects (methods, program relevance, broad applicability, and time required). We thought the criteria were also useful for evaluating project results.

Methods: For context, we provided a brief statement on project methods. The scientific soundness of the methods had already been evaluated in previous ISRP project reviews.

Program relevance and brief summary of findings: We considered the following questions from the 2014 Program when providing comments on this subsection. Do the results demonstrate that the project is addressing (or providing data to address) "hypotheses relevant to management decisions, an underlying assumption of the program, and … expected effectiveness outcomes"? Does the fish, wildlife, and/or habitat status and trend monitoring data collected by the project help with "tracking quantitative biological objectives, reporting on indicators, and informing statistical models such as life-cycle models, informs baseline information needed to track progress toward program goals and objectives"? We briefly summarized major findings generated by the projects, with the understanding that readers could access projects' progress reports for details through links provided with each annual report evaluation.

Broad applicability: Do the results have widespread applicability? Were the data "collected in a way that allows results to be applicable at multiple scales" such as across watersheds, species, or topics?

Time required: Has the project generated and reported results? Or is the project "likely to generate conclusions in a reasonable amount of time that is generally considered to be three to five years"?

In addition, some of our annual report evaluations contain comments on whether projects directly examined density dependence or whether projects collected data that could be used to test for density dependence during one or more life stages. In most cases, this would require many years of data so that sufficient contrast in densities might be available.

Although the evaluation was focused on the contributions of projects to addressing critical uncertainties, we gained a greater understanding of the Program's implementation through this annual report evaluation. We encourage project proponents to examine the comments as a means to improve project reporting and implementation.

General Comments on Annual Reports

To assess progress in addressing critical uncertainties in the 2006 Research Plan, the ISAB and ISRP reviewed the most recent annual reports from 187 Program projects with a research, monitoring, or evaluation work element. This task was more challenging than expected because projects varied in their scale of investigation, focus, and history, and annual reports varied considerably in timeliness and level of synthesis.

Project scale: Most projects were designed to answer specific questions at the local or subbasin scale. Consequently, projects often lacked a strategic approach for resolving critical uncertainties at the landscape scale. The ISAB and ISRP believe that better integration of projects across different parts of the Basin is needed to successfully address many of the critical uncertainties. Significant additional work will be needed to identify basinwide priorities, cost-efficient funding, and reasonable time frames for RME activities at a landscape scale. Three possible options to facilitate these tasks are (1) create a Research Institute, (2) promote collaborative research design and implementation teams, and/or (3) solicit basinwide proposals to focus on specific uncertainties (see Part 1, *Establishing Infrastructure Needed to Address Uncertainties*).

Landscape perspective: Many projects focus on active habitat restoration and hatchery management. Given that it is so expensive and difficult to restore damaged watersheds and habitats, the ISAB has recommended that a high priority be placed on identifying and protecting habitats that will provide the greatest benefits (ISAB 2011-4). In practice, this means identifying a network of fully functioning watersheds and key habitats (refuges) and monitoring the effectiveness of management practices to conserve or restore them. Other options to move the Program toward a landscape perspective are presented as Programmatic Comments in Part 1.

Response to ISRP reviews: Reviewers were pleased to see that many annual reports acknowledged past ISRP reviews, and that ISRP advice had often been incorporated into project activities.

Project changes and tracking: In some cases project objectives appear to have shifted over time, even though the project name and identification numbers have remained the same. This identification system complicates the task of tracking the actual focus of individual projects over time. To simplify future reviews of progress on addressing uncertainties, we suggest that the identity of projects be linked to their objectives; that is, if the objectives change, then the project title and identification number should change too.

Reporting delays: Reporting was behind schedule for a large number of projects in that an annual report for 2014 was not available at the time of our review in 2015. A small subset of projects had not submitted annual reports for several years; however, annual reports for 2013 were available for most projects. This is an issue for BPA to address with project proponents.

Linkage to uncertainties: Stronger linkages between project reporting and critical uncertainties in the Research Plans would help in tracking progress. Without being burdensome, the annual reporting process should require project teams to explicitly identify which uncertainties are being addressed, and how.

Multi-year result syntheses: The annual reports we reviewed typically provided appropriate detail about activities and results for the year in question, but many did not provide enough discussion or integration of results from previous years. More synthesis and retrospective discussion would be very useful. The BPA annual progress report template should be updated to request a brief retrospective summary of results.

Effective reporting: Reviewers noticed that annual reports for projects that consisted primarily of research activities (about 30 of the 187 RME projects) were generally superior to those for other projects. These annual reports typically followed the recommended format, included consistent summaries of data, and good discussion of findings. The 10 projects listed in Table D.1 were selected as examples of excellent annual reporting and would be useful for project proponents to review when they prepare their next annual reports.

Table D.1. Exemplary Annual Reports

Project titles in the table are hyperlinked to the reviewers' comments in this document.

199801400 - Ocean Survival of Salmonids
199102900 - Research, Monitoring, and Evaluation of Emerging Issues and Measures to Recover the Snake River fall Chinook Salmon ESU
200203200 - Snake River Fall Chinook Salmon Life History Investigations
199801900 - Wind River Watershed
200205300 - Asotin Creek Salmon Population Assessment
200900400 - Monitoring Recovery Trends in Key Spring Chinook Habitat Variables and Validation of Population Viability Indicators
201003200 - Imnaha River Steelhead Status Monitoring
200302200 - Okanogan Basin Monitoring & Evaluation Program (OBMEP)
200800700 - Upper Columbia United Tribes (UCUT) Monitoring and Evaluation (M&E) Program
201007700 - Tucannon River Programmatic Habitat Project

Issues to address: In contrast, annual reports for habitat restoration and protection projects were highly variable in format and content. Many reports appear to have been a bureaucratic afterthought and seem to reflect disregard for the adaptive management value of annual reporting. Consequently, without improvement, it will be difficult for the ISRP to base a scientific evaluation of the Program's effectiveness on annual reports. In 2012, Bonneville Power Administration instituted a reporting system through their Taurus database, and we recommend that this be followed (See *Instructions for Completing RM&E Reports*). The following sample of comments by ISRP and ISAB reviewers is included to highlight common problems that future annual reports should address if needed:

- There is no consistent set of approaches/methods used for project implementation and effectiveness monitoring.
- The project does not appear to have a well-documented monitoring plan that lists key monitoring questions, techniques and timelines.
- There is a general lack of data evaluation and results reporting.
- There is very limited documentation of how findings are applied to adjust or improve future restoration work (location, design and/or implementation). This lack of applying RME findings to future project work appears strongly related to the general lack of quantitative objectives with a time frame for expected results, which would serve as a foundation or reference for comparing predicted versus actual results.
- The project does not summarize findings or lessons learned from past or ongoing RME activities.
- There is insufficient linkage between project-level monitoring and basinwide programs (CHAMPS, ISEMP, Action Effectiveness Monitoring [AEM]).
- There seems to be confusion about whether or not it is appropriate to conduct any project level, effectiveness monitoring beyond that being provided by the three basinwide programs (CHAMPS, ISEMP, AEM). It appears that low cost, but useful, monitoring techniques are not being considered or applied.
- There appears to be a conflict between project proponents and BPA regarding what constitutes appropriate, project scale monitoring (activities, time frames) and a willingness to provide funding for it.

Project Contributions to Uncertainties Research

Ocean

199801400	Ocean Survival Of Salmonids	National Oceanic and Atmospheric Administration
200300900	Canada-USA Shelf Salmon Survival Study	Canada Department of Fisheries and Oceans

Summary

Two projects directly address uncertainties related to survival of Columbia River salmonids in the ocean. The projects focus on uncertainties related to juvenile salmonid growth and survival during the first ocean year in marine habitats along coastal migration corridors from Oregon to Southeastern Alaska. There are currently no BPA-funded projects that address uncertainties about marine survival at life stages beyond the first ocean year or in oceanic (high seas) habitats.

199801400 - Ocean Survival of Salmonids

Links to: project **and** reports

Proponent: National Oceanic and Atmospheric Administration

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles and from harvest in fisheries targeting hatchery-origin adults?
- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

- Plume and Ocean: Can monitoring of ocean conditions and abundance of salmon and steelhead during their first weeks or months at sea improve our ability to predict interannual fluctuations in the production of Columbia Basin Evolutionarily Significant Units (ESUs) or populations to enable appropriate changes to harvest levels?
- Plume and Ocean: Can stock-specific data on ocean abundance, distribution, density-dependent growth and survival, and migration of salmonids, both hatchery and wild, be used to evaluate and adjust marine fishery interceptions, harvest, and hatchery production in order to optimize harvests and ecological benefits within the Columbia River Basin?
- Plume and Ocean: How can interannual and interdecadal changes in ocean conditions be incorporated into management decisions relating to hydrosystem operations, the numbers and timing of hatchery releases, and harvest levels to enhance survival rates, diversity, and viability of ESA-listed salmonids?

Indirect or Potential:

- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Climate Change: Can indices of climate change be used to better understand and predict interannual and interdecadal changes in production, abundance, diversity, and distribution of Columbia Basin fish and wildlife?

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- Monitoring and Evaluation (adaptive management): Can predictive models be used to evaluate the potential impacts of hydrosystem projects on estuary, plume, and coastal marine habitats?
- Plume and Ocean: What is the combined effect of the warm water mass that emerged off the Pacific Northwest coast in 2013 (the “blob”) and El Nino and La Nina conditions?

Comment:

This project directly and indirectly (by providing data) addresses a number of critical uncertainties associated with the Columbia River estuary, plume, and nearshore marine areas. It provides a good mix of hypothesis testing, monitoring, and evaluation. Presentation and publication of results is outstanding and on time. This is a model project for the Columbia River Fish and Wildlife Program.

***Climate change uncertainty**:* The project collects time series data at multiple scales (daily, seasonal, interannual, and decadal) on juvenile salmon and ecosystem conditions in the Columbia River plume and coastal marine habitats. The data can be used to address climate change uncertainty; however, because of high interannual variability in ocean conditions in the California Current ecosystem, a longer time series of data are needed to achieve sufficient statistical power to test hypotheses at decadal scales. Nevertheless, the time series of data on climate and ocean conditions indicates that the northern California Current experienced a regime shift beginning in late 1998, and as a result Columbia River salmonid survival has shown a five-fold increase. Thus, to address uncertainties about whether management and restoration actions in the Basin have increased anadromous salmonid productivity, it is necessary to incorporate data on increased ocean survival since 1998.

Fish propagation uncertainties: The project examines hypotheses related to growth, survival, and density-dependent interactions of hatchery and wild salmon during the early ocean life-history phase.

Monitoring and evaluation (adaptive management) uncertainties: The project uses linear/non-linear regressions, PATH analyses, Structural Equation Modeling, Bayesian Beliefs Network, and Green-Yellow-Red light traffic system models to test hypotheses related to salmonid survival and habitat and to forecast adult salmon returns. Predictive models developed by the project have contributed to adaptive management of hydrosystem projects, for example, the Columbia River Channel Improvement Project, which resulted in agreements on post-completion effects on the estuary and plume. Overall, the project results are vital to evaluation of uncertainties related to the effectiveness of management actions and habitat strategies within the Columbia River hydrosystem by providing data needed to distinguish between freshwater and ocean effects on salmonid survival.

Plume and ocean uncertainties: The project examines stock-specific hypotheses about trophic (bottom-up and top-down) factors that may affect growth and survival of Columbia River salmonids in plume and early marine coastal habitats. However, to our knowledge the results of these analyses have not been used to adjust harvest, hatchery, or hydrosystem management.

Methods: This project has multiple objectives that use a variety of methods (e.g., fish and oceanographic surveys in May, June, and September; genetic stock identification; and stomach content, stable isotope, fatty acid, parasite, otolith microstructure, and Insulin-like growth factor-1 analyses). Many of the methods have been published in peer reviewed scientific papers and have passed review. The methods are well documented and appropriate for the objectives. Precision will depend on the sample sizes, and the ISAB agrees with previous reviews that a time series approach with autocorrelation is appropriate for some of the objectives. Sample sizes are sometimes insufficient due to the low abundance of salmonids relative to other marine species in the California Current Ecosystem.

Program Relevance and Project Results: This project addresses a number of critical uncertainties associated with the Columbia River plume and nearshore marine areas. It provides a good mix of hypothesis testing, monitoring, and evaluation. The project sets out testable hypotheses that can be queried with their data. This is one of the best ways to advance science. The findings were extensive and well analyzed with appropriate statistical tests.

Research: The project tests hypotheses about trophic (bottom-up and top-down) factors and plume, estuary, and tidal river structure that may affect growth and survival of Columbia River salmonids during plume and early marine residence. As necessary components of addressing these hypotheses the project has also determined when and where specific ESUs and stock groups of juvenile salmonids are found in the estuary, plume, and nearshore coastal habitats and measured physical habitat conditions to identify relationships among these conditions and salmon survival. See detailed results in the latest annual report (https://pisces.bpa.gov/release/documents/DocumentViewer.aspx?doc=P142906) and in the 1998-2011 Ocean Synthesis report (www.nwcouncil.org/media/13624/MarineEcology2012.pdf).

Status and Trend M&E: The salmonid and ocean habitat status and trend monitoring data collected by the project help with tracking quantitative biological objectives, reporting on indicators (annual stoplight chart on ocean survival indicators), informing statistical models such as life-cycle models, and informing baseline information needed to track progress toward program goals and objectives. The scale of effort includes the juvenile life history phase in the Columbia River lower estuary, the Columbia River Plume, and the California Current ecosystem. See detailed results at https://pisces.bpa.gov/release/documents/DocumentViewer.aspx?doc=P142906.

Project level monitoring: This is the only Columbia River plume and adjacent (Oregon and Washington) coastal ocean project currently funded by BPA, and as such provides the only data that will inform high-level indicators related to juvenile salmon survival in the continuum of habitats from the estuary to the plume to the early ocean phase in the California Current ecosystem. In terms of potential adaptive management, project results are highly relevant to hatchery management practices in the Columbia River Basin, indicating that modification of some hatchery practices could result in improved estuary/plume/early ocean survival of both hatchery and wild fish, although the ISAB/RP does not have specific information on how managers might be implementing changes based on project results. See relevant results at https://pisces.bpa.gov/release/documents/DocumentViewer.aspx?doc=P142906)

Broad Applicability: The results have widespread applicability because all Columbia River anadromous salmonids pass through the plume and nearshore. The data were collected in a way that allows results to be applicable at multiple spatial, temporal, biological, and physical scales. If coordinated well with other BPA projects, this project will provide widely valuable insights. Because of increasing annual variability and unexpected and unprecedented recent changes in climate and ocean conditions in the California Current Ecosystem, annual monitoring results from this project are a very important contribution to addressing uncertainties in the Council's Fish and Wildlife Program.

Time Required: This has been a long-term project but for use in a time-series approach would be considered too short to provide evidence of cyclic behavior. The value of program increases with each additional year of data. The project reported results in a timely manner, and future results are anticipated in a reasonable amount of time.

200300900 - Canada-USA Shelf Salmon Survival Study

Links to: project **and** reports

Proponent: Canada Department of Fisheries and Oceans

2006 Research Plan uncertainties addressed:

Direct:

- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

- Plume and Ocean: Can monitoring of ocean conditions and abundance of salmon and steelhead during their first weeks or months at sea improve our ability to predict interannual fluctuations in the production of Columbia Basin Evolutionarily Significant Units (ESUs) or populations to enable appropriate changes to harvest levels?
- Plume and Ocean: Can stock-specific data on ocean abundance, distribution, density-dependent growth and survival, and migration of salmonids, both hatchery and wild, be used to evaluate and adjust marine fishery interceptions, harvest, and hatchery production in order to optimize harvests and ecological benefits within the Columbia River Basin?
- Plume and Ocean: How can interannual and interdecadal changes in ocean conditions be incorporated into management decisions relating to hydrosystem operations, the numbers and timing of hatchery releases, and harvest levels to enhance survival rates, diversity, and viability of ESA-listed salmonids?

Indirect or Potential:

- Climate Change: Can indices of climate change be used to better understand and predict interannual and interdecadal changes in production, abundance, diversity, and distribution of Columbia Basin fish and wildlife?
- Climate Change: Can integrated ecological monitoring be used to determine how climate change simultaneously affects fish and wildlife and the freshwater, estuarine, ocean, and terrestrial habitats and ecosystems that sustain them?
- Climate Change: What long-term changes are predicted in the Columbia River Basin and the northeast Pacific Ocean, how will they affect the fish and wildlife in the region, and what actions can ameliorate increased water temperatures, decreased summer river flows, and other ecosystem changes?
- Habitat Estuary, Plume and Ocean: What specific factors affect survival and migration of species and life-history types of fish through the estuary, and how is the timing of ocean entry related to subsequent survival?
- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?

Comment:

This project directly and indirectly (through collection of data) addresses a number of critical uncertainties associated with species- and stock-specific abundance, distribution, growth, survival, and migration of Columbia River salmon in coastal marine areas off British Columbia and Southeastern Alaska. It provides a good mix of hypothesis testing, monitoring, and evaluation. Presentation and publication of results are outstanding.

***Climate change uncertainty**:* The project collects time series data at multiple scales (daily, seasonal, interannual, and decadal) on juvenile salmon and ecosystem conditions in coastal marine habitats. The data eventually can be used to address climate change uncertainty. However, because of high interannual variability in ocean conditions a longer time series of data are needed to achieve sufficient statistical power to test hypotheses at decadal scales.

Fish propagation uncertainties: The project recovers coded-wire tagged (CWT)/adipose fin clipped hatchery fish and uses genetic stock identification to describe distribution and migration patterns of Columbia River Basin hatchery and wild salmon. The CWT and genetic stock identification data can be used to test hypotheses related to growth, survival, and density-dependent interactions of hatchery and wild salmon during the early ocean life-history phase.

Monitoring and Evaluation (adaptive management) uncertainties: The project uses linear/non-linear regressions, PATH analyses, Structural Equation Modeling, Bayesian Beliefs Network, and Green-Yellow-Red light traffic system models to test hypotheses related to salmonid survival and habitat and to forecast adult salmon returns. Overall, the project results are vital to evaluation of uncertainties related to the effectiveness of management actions and habitat strategies within the Columbia River hydrosystem by providing data needed to distinguish between freshwater and ocean effects on salmonid survival.

Plume and ocean uncertainties: The project tests stock-specific hypotheses about trophic (bottom-up and top-down) factors that may affect growth and survival of Columbia River salmonids in marine coastal habitats from British Columbia to Southeastern Alaska. However, to our knowledge the results of these analyses have not been used to adjust harvest, hatchery, or hydrosystem management.

Methods: This project has collected juvenile salmon and oceanographic data off the west coast of British Columbia and Southeast Alaska since 1998 to assess the effects of ocean conditions on the distribution, migration, growth, and survival of Pacific salmon. The project uses a variety of methods (e.g., ageing, growth, stable isotopes, fish and oceanographic surveys, genetic stock identification, coded-wire tags, stomach content analysis, fatty acids, Insulin-like growth factor-1, and mass balance model of inert chemical tracers) to assess growth and survival of different stocks from the Columbia River that have migrated to Canadian and Alaskan waters. Generally accepted analytic and statistical methods were used.

Research: The working hypothesis addressed by this project is that the effects of ocean conditions on salmon growth during their first year at sea mediate marine survival of salmon. Fast growing salmon are expected to have higher marine survival than slow growing salmon either because they grow large enough to avoid predators or because they store sufficient lipids to survive the first winter at sea. The research is coordinated with juvenile salmon sampling programs conducted by NMFS from California to Washington and in Alaska.

Program Relevance and Project Results: This project is highly relevant to the Program, addressing critical uncertainties associated with juvenile salmon growth and survival during their first year in the ocean. The results show that ocean conditions experienced by Columbia River Chinook, coho, and sockeye vary among coastal ocean regions (e.g., higher plankton productivity and sea surface temperatures off Vancouver Island than off Southeastern Alaska) and that marine growth and survival of Columbia River Chinook, coho, and sockeye are strongly influenced by ocean conditions off the west coast of Vancouver Island. Detailed results are provided in the most recent annual report (https://pisces.bpa.gov/release/documents/DocumentViewer.aspx?doc=P127650) and in the 1998-2011 Ocean Synthesis report (https://www.nwcouncil.org/media/13624/MarineEcology2012.pdf). This is an important companion study to the Ocean Survival of Salmonids project (NOAA Fisheries), extending the spatial scope of information on ocean survival to northern waters. This spatial component is important because many major Columbia River species and stocks migrate rapidly northward after ocean entry to coastal marine habitats off British Columbia and Alaska and use these habitats for feeding. The ocean beyond the Columbia River remains a critical uncertainty with regard to salmon survival and abundance.

Broad Applicability: The results of this project are broadly applicable to all northward migrating stocks of Columbia River salmon and a necessary component to a better understand uncertainties related to oceanic habitat of juveniles and the effect that oceanic conditions have on their growth and survival.

Time Required: For oceanic monitoring, the longer the time series the better for interpreting changing ocean conditions. Project reporting is timely and comprehensive. Value increased with each additional year of data.

Hydrosystem Passage and Related Life History Work

198331900	New Marking and Monitoring Technologies	National Oceanic and Atmospheric Administration
199008000	Columbia Basin Pit-Tag Information	Pacific States Marine Fisheries Commission
199302900	Survival Estimate for Passage through Snake and Columbia River Dams and Reservoirs	National Oceanic and Atmospheric Administration
200500200	Lower Granite Dam Adult Trap Operations	National Oceanic and Atmospheric Administration
200304100	Evaluate Delayed (Extra) Mortality Associated with Passage of Yearling Chinook Salmon through Snake River Dams	National Oceanic and Atmospheric Administration
199102800	Pit Tagging Wild Chinook	National Oceanic and Atmospheric Administration
198712700	Smolt Monitoring by Non-Federal Entities	Pacific States Marine Fisheries Commission, Fish Passage Center
199403300	Fish Passage Center	Pacific States Marine Fisheries Commission
199602000	Comparative Survival Study (CSS)	Pacific States Marine Fisheries Commission
198910700	Statistical Support For Salmon	University of Washington
199601900	Data Access in Real Time (DART)	University of Washington
199105100	Modeling and Evaluation Statistical Support for Life-Cycle Studies	University of Washington
200851800	Upstream Migration Timing	Columbia River Inter-Tribal Fish Commission (CRITFC)
200890800	FCRPS Water Studies & Passage of Adult Salmon & Steelhead	Colville Confederated Tribes
199900301	Evaluate Spawning of Fall Chinook and Chum Salmon Just Below the Four Lowermost Mainstem Dams	Oregon Department of Fish and Wildlife, Pacific Northwest National Laboratory, Pacific States Marine Fisheries Commission, Washington Department of Fish and Wildlife (WDFW)

Summary

The hydrosystem projects have extensively evaluated individual aspects of the hydrosystem, such as individual dam passage survival, for many years. The extensive infrastructure in place is very useful to aid in evaluating the impact of habitat restoration activities and to provide monitoring for the impacts of future change, for example climate change.

Up to now, the hydrosystem projects have relied on PIT-tagged fish, and additional efforts are being made to add more PIT tag detectors to dams (e.g. on spillways), in natal streams (e.g. instream arrays), and in the estuary (e.g. towed arrays). Individual dam performances are also evaluated using acoustic- and radio-tagged fish to measure route of passage selection and survival. Less work has been done on estimating abundance of smolts through the hydrosystem. This is important because of potential density dependence effects as habitat restoration activities are completed. To estimate abundance, the PIT-tagged fish monitoring will have to be augmented with additional surveys to assess the total spatial and temporal distribution of smolts.

More work is needed on returning adult passage issues due to the difficulty in getting enough tagged adults of known origin returning through the hydrosystem. Some potential gains in efficiency could be obtained if adult fish were intercepted, their stock status determined by genetic stock identification (GSI), followed by tagging rather than relying solely on tagged smolts that survived to the adult stage. This should only occur, however, if environmental circumstances (water and air temperatures) and fish condition are deemed acceptable for fish handling and tagging operations.

With now more than 20 years of data, projects have also evaluated the impacts of covariates, such as spill, on smolt performance measures. Results from those studies have given rise to a proposed experiment to investigate the impact of planned and sustained increased spill on performance. While this work is laudable, the largest source of mortality and largest source of uncertainty about the relationships between covariates and survival is the ocean. While some work has been done to investigate the optimal allocation of tagging (IEAB 2013-1), more work is needed on deciding where the next marginal dollar should be spent. The lifecycle modeling efforts that have been reviewed by the ISAB and should provide useful guidance on where marginal benefits in gaining information are greatest. Similarly, more attention should be paid to how the current tagging program could provide better information on ways that ocean survival could be improved by changes in operations. For example, certain operations may improve hydrosystem survival but impair ocean survival. This tradeoff needs to be more explicitly evaluated.

Similarly, program goals should be expanded not only to improve, for example, mean hydrosystem survival, but also focus to on reducing variability. There is now likely sufficient years of data collected to identify parts of the hydrosystem with larger variances in the response measure, such as survival. A lower average yearly survival rate with very little yearly variability may lead to a more robust ecosystem than one with a higher average survival rate but with high yearly variability. Research should focus on which areas have high variability in response measures and how to reduce this.

198331900 - New Marking and Monitoring Technologies

Links to: project **and** reports

Proponent: National Oceanic and Atmospheric Administration

Uncertainties addressed:

No 2006 Research Plan uncertainties are directly examined by this project. However, the products produced from this project will help address many of these uncertainties.

Comment:

This project develops PIT tag detection equipment for spillways and instream applications that are used by many research, monitoring, and evaluation projects that are addressing critical uncertainties. Specifically, this tagging technology is the backbone of many projects where fish movement and survival are studied.

Methods: The project focuses on the development of PIT tag technology, particularly faster tags and readers for spillways and instream applications. The project has been stopped at various times due to concerns by the Corps and others on attachments of PIT-tag readers to spillway gates.

Program Relevance and Project Results: The goal to improve PIT tag interrogation systems for spillways has not been successful. The goal of improving in-stream PIT tag systems has not been completed, but a data collection system for such systems has been developed. Because of low detection probabilities, the statistical uncertainty of survival estimates based on PIT tag detection is likely to be high. For example, detection rates at Bonneville Dam spillway need to be 30%+ along with 2-4% detection in the trawl below Bonneville to bring standard errors for survival between McNary and Bonneville dams to acceptable levels. The regional coordination task has been hampered because a PIT tag plan for the region has not been completed.

The annual report for 2015 does not indicate what progress has been made from 2012 up to the present. Additionally, no reference is made to the Council's Tagging Forum, the IEAB's report on optimizing tagging, or the CSS reports on data gaps for direction on where to concentrate efforts, but these later sources occurred after 2011 which is the latest period covered by the current report.

Broad Applicability: Any program that uses PIT tags could benefit from this work.

Time Required: The last annual report covers activities up to 2011, so it is not clear what has happened during the past 5 years. Based on the difficulties that occurred in 2011, fulfillment of the project objectives might be 5-10 years away.

199008000 - Columbia Basin PIT-Tag Information

Links to: project **and** reports

Proponent: Pacific States Marine Fisheries Commission

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Mainstem Hydrosystem Flow and Passage Operations: Under what conditions is delayed mortality related to downstream migration through the hydrosystem, and what is the magnitude of that delayed mortality?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species and stocks? What are the ecological effects of hydrosystem operations on downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?
- Population Structure and Diversity: What are the differential effects of flow augmentation, transportation, and summer spill on “ocean type vs. reservoir type” fall Chinook?

Comment:

The relationship to the uncertainties is indirect because this project maintains the PTAGIS System which stores information on the number of PIT tagged fish released and their detections in the Columbia River Basin.

Methods: This project provides support for the PTAGIS system. It maintains the database and installs, operates, and maintains field interrogation systems. The project does not perform any analyses on these data.

Program Relevance and Project Results: The program provides the necessary database support for its users. They monitor the quality of data input and provide support for field equipment. Over 2 million records for newly tagged fish and 13 million detections of tagged fish were entered in 2014. The interrogation sites have very high detection rates (over 90%).

Broad Applicability: The development and maintenance of this database is an important element in the use of PIT tags for most projects in the system.

Time Required: This is the 26th year that the project has been in operation and providing real time information. The key limitation is getting data from different PIT tag monitoring sites into the database, but for many sites this now occurs in real time.

198712700 - Smolt Monitoring by Non-Federal Entities

Links to: project **and** reports

Proponent: Pacific States Marine Fisheries Commission, Fish Passage Center

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Mainstem Hydrosystem Flow and Passage Operations: Under what conditions is delayed mortality related to downstream migration through the hydrosystem, and what is the magnitude of that delayed mortality?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, in-river return rates, and measurements of juvenile survival (D values)?

Comment:

The project's relationship to the uncertainties listed above is indirect because data obtained from fish tagged by the project feed into Fish Passage Center (FPC) products funded by other proposals.

Methods: This project is responsible for PIT-tagging smolts at three hatcheries. After release the fish are then tracked through the hydrosystem.

Program Relevance and Project Results: The Columbia River Fisheries Program Office is under contract from the Fish Passage Center and Bonneville Power Administration to provide PIT tagging services at Leavenworth National Fish Hatchery and two Washington State facilities the Priest Rapids and Wells hatcheries. A total of about 24,000 Chinook are annually PIT-tagged.

Results are integrated into FPC reports and products. Additionally, data from this project could potentially could be used to study density dependence if, for example, the rearing density of the tagged smolts was modified in an experimental design.

Broad Applicability: This project is very specific since its objective is to annually tag juvenile Chinook salmon at three hatcheries. However, data obtained from the tagged fish may be used to address a number of fish passage and survival questions.

Time Required: This program will continue into the foreseeable future.

199403300 - Fish Passage Center

Links to: project **and** reports

Proponent: Pacific States Marine Fisheries Commission

2006 Research Plan uncertainties addressed:

Direct:

- Mainstem Hydrosystem Flow and Passage Operations: Under what conditions is delayed mortality related to downstream migration through the hydrosystem, and what is the magnitude of that delayed mortality?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?

Indirect or Potential:

- Mainstem Hydrosystem Flow and Passage Operations: What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species and stocks? What are the ecological effects of hydrosystem operations on downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?

Comment:

The Fish Passage Center reports on smolt movement and hydrosystem operations and does extensive analyses of data collected on smolts. These are performed to investigate the effects of many factors on smolt performance.

Methods: There are many methods used given the wide scope of the FPC products. The ISAB has extensively reviewed the methods.

Program Relevance and Project Results: The Fish Passage Center monitors hydrosystem operations, environmental conditions, and the resulting fish passage characteristics that occurred during a year. It serves as the basis for evaluation of many projects in the basin.

All reservoir operations combined in 2014 resulted in limited success in meeting Biological Opinion seasonal flow targets in the Snake River, but Biological Opinion seasonal flow targets in the Columbia River were exceeded during the spring migration and nearly met during the summer period.

Flows in 2014 were close to average, therefore only small amounts of uncontrolled spill occurred during high runoff periods. Spill at Lower Monumental Dam was consistently constrained due to high total dissolved gas (TDG). Lower summer spill levels were implemented earlier than dates established by the Biological Opinion at a number of the federal hydroelectric projects in order to conduct summer spill research when greater numbers of fish were present. Spill plans at the Upper Columbia projects varied from no spill to fixed volumes or percentages during spring and summer.

The action criteria that serve as “early warning” indicators for potential lethal Gas Bubble Trauma (GBT) conditions were not exceeded in 2014.

The Smolt Monitoring Program generated fish passage metrics including juvenile fish travel time, survival, passage timing, and passage duration. In general juvenile passage data (i.e., travel time and survival) for 2014 for the Snake River and the upper and middle Columbia River were consistent with the historical data time series for the water travel times that occurred in 2014, with the notable exception of Upper Columbia River sockeye. Juvenile survival is higher and juvenile travel time is faster when water travel time is faster and spill is higher. In 2014 survival and travel time was average even though some cohorts migrated in flows that were below the Biological Opinion seasonal flow targets and slow water travel times occurred for extended periods of time.

At Wanapum Dam a significant crack was discovered in a spillway monolith on February 27, 2014. This discovery led to an emergency drawdown of the Wanapum pool to an elevation which was over 20 feet below its typical forebay elevation.

The 2014 adult spring and summer Chinook counts increased throughout most of the basin when compared to both of the 2013 and 10-year average counts. The 2014 fall Chinook adult counts in mid-

Columbia and Snake Rivers increased on average 200% throughout the basin when compared to the 10-year average counts. The 2014 adult sockeye counts increased significantly throughout the basin when compared to the 2013 counts and the 10-year average counts. The 2014 adult steelhead counts increased when compared to the 2013 counts and slightly decreased when compared to the 10-year average counts.

In the Snake River Zone, the 2014 hatchery release total for all species combined was nearly 31.6 million, which is the highest release total for this zone in the FPC database. In the Mid-Columbia Zone (Upper Columbia River), total hatchery release levels for spring Chinook, summer Chinook, and steelhead in 2014 were generally lower than their respective 10-year averages. The 2014 release totals for fall Chinook and coho in the Mid-Columbia Zone (Upper Columbia River) in 2014 were higher than their respective 10-year averages for this zone. At nearly 30.4 million juveniles, the hatchery release total in the Lower Columbia River Zone (Bonneville to McNary) for 2014 was well below the current 10-year average for this zone.

This project could provide data to examine the effects of density dependence if the hatchery releases varied density in an experimental design.

Broad Applicability: Many programs and management rely on FPC products for M&E.

Time Required: Reports are created annually. The Fish Passage Center will operate for the foreseeable future.

199602000 – Comparative Survival Study (CSS)

Links to: project **and** reports

Proponent: Pacific States Marine Fisheries Commission (Government - Federal), US Fish and Wildlife Service (USFWS) (Government - Federal), Fish Passage Center (Non-Profit)

2006 Research Plan uncertainties addressed:

Direct:

- Mainstem Hydrosystem Flow and Passage Operations: Under what conditions is delayed mortality related to downstream migration through the hydrosystem, and what is the magnitude of that delayed mortality?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate,

and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?

- Population Structure and Diversity: What are the differential effects of flow augmentation, transportation, and summer spill on “ocean type vs. reservoir type” fall Chinook?

Indirect or Potential:

- Habitat Estuary, Plume and Ocean: What is the significance to fish survival, production, and life-history diversities of habitat degradation or restoration in the estuary as compared with impacts to other habitats in the basin? How does this partitioning of effects vary among species and life-history types?
- Habitat Estuary, Plume and Ocean: What specific factors affect survival and migration of species and life-history types of fish through the estuary, and how is the timing of ocean entry related to subsequent survival?
- Mainstem Hydrosystem Flow and Passage Operations: What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species and stocks? What are the ecological effects of hydrosystem operations on downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?

Comment:

The Comparative Survival Study (CSS) is the most reviewed Fish and Wildlife Program project. Every September/October, the ISAB reviews this project’s annual reports. The CSS directly addresses the hydrosystem critical uncertainties listed in the 2006 Research Plan and indirectly addresses several others. The ISAB recently reviewed the draft CSS 2015 Annual Report (ISAB 2015-2). The ISAB concluded, “These reports are extremely valuable to many stakeholders in the Basin for many different purposes, and the data collection and reporting should be continued.” A summary of our review follows:

> The annual CSS report is a mature product, typically including only updates with the latest year of data and expansion of analyses as more data are acquired. Many of the methods have been reviewed in previous ISAB reports and so now receive only a cursory examination. As more data are acquired, new patterns and questions arise on the interpretation of the results – this is now the primary focus of the ISAB’s reviews. The ISAB appreciates the detailed response of the CSS to suggestions provided in previous reviews. The ISAB does not expect that the CSS would necessarily respond immediately to new requests for further analyses.
>
> Chapter 1 is similar to previous years with the 2013 results added. The report now disaggregates results for Snake River wild steelhead and Chinook to the major population group (MPG) level. The results in Chapter 1 appear to show a natural experiment involving the effects of mainstem discharge on salmon survival with the proportion of downstream transportation of juveniles and proportion of spill being roughly constant since 2006, but total flow in the river differing among years. The ISAB suggests that focused analyses (graphs and formal analyses) be conducted on this natural experiment to test statistical relationships between flow and salmon population parameters such as survival, smolt-to-adult-return rate (SAR), and other response variables.

In Chapter 2, an updated Life Cycle Model (LCM) is presented that relates juvenile survival of transported and un-transported cohorts of juvenile fish and a PIT-tag based indicator of powerhouse passage. This is useful refinement of the LCM, and the ISAB looks forward to additional refinements such as the inclusion of additional terminal areas and further partitioning of survival. The LCM was used to investigate the long-term impacts of increased salmon productivity and reduced dam effects on the long-term persistence of salmon populations. It would be helpful to reverse this analysis and evaluate what combinations of increased productivity and reduced dam contact might lead to sustainable populations.

Chapter 3 is mainly an update with the latest information on in-river effects on juvenile travel time, instantaneous mortality, and survival. A key finding is that there is large variation in the results among years and among cohorts. The variation among years is understandable; the variation within a year less so. Many figures (e.g., Figure 3.2) show a consistent pattern in fish travel time and survival over cohorts as the year progresses. The discussion lists potential explanations for the effect of “day.” Can planned or natural experiments be designed to distinguish among these hypotheses and is it worthwhile to do so? For example, do these relationships provide information on optimal timing of releases for hatchery fish? It is also not clear if these cohort effects continue to the final performance measures (e.g., SARs). Data are clearly too sparse to investigate this question for individual cohorts, but can a more gross separation be used (e.g., a simple split of cohorts into two parts – early vs. late)?

Chapter 4 described overall annual SARs and was updated with new data; details are presented in Appendices. Additionally, the authors investigate relationships between SARs and salmon population productivity (return per spawner) and inter-stock correlations among SARs. These chapters and appendices will continue to expand over time. Is there a better way to present the results than in an ever-expanding set of graphs and sets of tables? As indicated in the report, different SAR objectives will require different accounting locations (e.g., finer geographic locations) and methods (e.g., for persistence at local or basin levels). The current tables and plots are generally well done, but as can be imagined, this chapter could become overwhelming. The ISAB suggests that consideration be given to how to present these results in the future to best serve the various stakeholders. Perhaps an electronic report that can be customized for a particular interest group may be more useful than a static paper document? The CSS report could then focus on unexpected findings or relationships (such as that between SAR and productivity or inter-cohort relationships).

Chapter 5 is mostly an update on Snake River sub-yearling fall Chinook. As with Chapter 4, some consideration is needed on the best way to present an ever-increasing amount of data so that the results of the data analyses are useful for stakeholders. This chapter also includes a new power analysis indicating how much additional tagging is needed for fall Chinook above Lower Granite Dam (LGR). Is it feasible to tag the required number of fish? Also, these additional tagged-fish will provide added information on down-river detection rates – does this lead to improvements elsewhere in the CSS domain of study?

The ISAB understands that Chapter 6 in the 2014 report (PIT-tag versus CWT survival estimates) is currently in preparation for the next iteration of the CSS report. Rather than report on incomplete analyses, it was removed from this year’s report. The ISAB looks forward to its inclusion next year. Evaluating potential bias in survival rates of PIT-tagged fish is an important topic.

Suggested Topics for Further Review

In 2013, the ISAB recommended these topics (ISAB 2013-4, Page 1):

1. Hypotheses on mechanisms regulating smolt-to-adult survival rates (SARs)
2. Life-cycle modeling questions and Fish and Wildlife Program SAR objectives
3. Data gaps
4. Rationalization of CSS's Passive Integrated Transponder (PIT)-tagging, and
5. Publication of a synthesis and critical review of CSS results

In 2014, the ISAB recommended these topics (ISAB 2014-5, pages 2-3):

1. Hypotheses on mechanisms regulating smolt-to-adult return rates (SARs) [update from 2013 review]
2. Life-cycle modeling questions and Fish and Wildlife Program SAR objectives [update from 2013 review]
3. New PIT/CWT study to further investigate differential survival among these tag types

The CSS group has incorporated many of the ISAB's suggestions into the current document. For example, the current report has a substantial discussion of correlations among SARs from different regions or effects of transport on SARs (#1 in 2013; #1 in 2014). The life cycle modeling now allows for variation in stream productivity and hydrosystem survival and simulates the correlative impacts of these changes on predicted future population abundances (#2 in 2013; #2 in 2014). Members of the CSS have now published many peer-reviewed articles synthesizing the results (#5 in 2013). The ISAB appreciates the CSS efforts to respond to the ISAB's queries which in turn lead to further questions as noted below.

However, some of the recommendations from the ISAB appear to be beyond the scope of the CSS. For example, the ISAB identified several data gaps such as fish body mass metrics (#3 in 2013), but limited resources and questions about which agencies should collect this information have prevented acquisition of these data. The CSS expends considerable effort to coordinate PIT-tagging in the basin with other groups but does not feel that it is the appropriate body for a full rationalization of the PIT-tagging effort (#4 in 2013) along the lines recommended by the IEAB report (2013-1). Resolution of these issues may require higher-level policy discussions among the stakeholders in the Basin. The update of Chapter 6 from last year (#3 in 2014) has been deferred until the next report.

In 2015, the ISAB recommends the following four topics for future reports:

1. Use SAR data to examine both intra- and interspecific density dependence during the smolt out migration and early marine periods.

ISAB (2015-1) found relatively little direct testing of density dependence during the smolt outmigration period when many natural and hatchery salmonids may co-mingle as they migrate toward the ocean. Would it be possible to use CSS SAR data to examine both intra- and interspecific density dependence during the smolt out migration and early marine periods? The potential for compensatory density dependence was suggested by bioenergetic estimates of numerous prey consumed by spring/summer Chinook as they migrate from Lower Granite Dam to Bonneville (ISAB 2011-1). Also, there was some evidence of depensatory mortality of smolts in the Snake River caused by foraging birds (see Fig. VII.1 of ISAB 2015-1).

2. Propose actions to improve SARs to pre-1970s levels.

The Chapter 4 Discussion provides a good summary of key information, leading to the conclusion that pre-harvest SARs of ~4-7% are needed to improve productivity to pre-1970s levels. Given the range in observed survivals at sea (S.oa), to what extent might actions in the mainstem Columbia and Snake rivers allow this to occur? What are the key actions predicted to influence survival to reach SARs of 4-7%? For example, can the Life Cycle Model simulation study be run in "reverse" to help evaluate the relative benefit of alternative management actions? These evaluations might support an actual test (like a spill-experiment).

3. Explore additional potential relations between SARs and climate and ocean conditions

The authors should consider further exploration of potential relationships between SARs and indices of climate and ocean conditions that have not been previously evaluated by CSS, e.g., the North Pacific Gyre Oscillation (NPGO; see Kilduff et al.2015; Miller et al. 2014),NOAA local biological indices (e.g., copepod biodiversity, northern copepod anomalies, biological spring transition, winter ichthyoplankton, juvenile catch-June), and Alaska Marine Ecosystem indicators. Similarly, can methods similar to Chapter 2 be used where years that are "similar" to those expected under future climate change scenarios are used to simulate the predictions for survival, SARS, and other population parameters under future climate scenarios.

4. Consider ways to explore the variability of inter-cohort responses

Finally, the CSS report has studied effects on the "mean" response to various factors. For example, fish travel time reductions improve "mean" survival, but as noted, there is high inter-cohort variability. Perhaps a lower average survival with less inter-cohort variability would be more beneficial, i.e. a more robust response. Are there management actions that could reduce this intra-cohort variability? The current time series is now approaching a length where this could be investigated in the future. Some planning is required to ensure that data collected now are stored in a format that will be suitable for future investigations along these lines.

See the full ISAB report for detailed comments on each CSS report chapter.

199302900 - Survival Estimate for Passage through Snake and Columbia River Dams and Reservoirs

Links to: project **and** reports

Proponent: National Oceanic and Atmospheric Administration

2006 Research Plan uncertainties addressed:

Direct:

- Mainstem Hydrosystem Flow and Passage Operations: Under what conditions is delayed mortality related to downstream migration through the hydrosystem, and what is the magnitude of that delayed mortality?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?
- Population Structure and Diversity: What are the differential effects of flow augmentation, transportation, and summer spill on “ocean type vs. reservoir type” fall Chinook?

Indirect or Potential:

- Habitat Estuary, Plume and Ocean: What is the significance to fish survival, production, and life-history diversities of habitat degradation or restoration in the estuary as compared with impacts to other habitats in the basin? How does this partitioning of effects vary among species and life-history types?
- Habitat Estuary, Plume and Ocean: What specific factors affect survival and migration of species and life-history types of fish through the estuary, and how is the timing of ocean entry related to subsequent survival?
- Mainstem Hydrosystem Flow and Passage Operations: What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species and stocks? What are the ecological effects of hydrosystem operations on downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- What detection rates at bypass facilities are needed to improve estimates of survival and travel time through the hydrosystem?
- What are the sources of mortality for all salmonid life-history stages in the upper tributaries?

Comment:

Additional Research, Monitoring and Evaluation Needs: Higher detection rates at bypass facilities and spill ways are needed to improve estimates of survival and travel time through the hydrosystem. Limited PIT tag detection systems in upstream tributaries also limit the overall benefit of this long-running monitoring program because sources of mortality cannot be identified.

This is a direct study of the survival and other characteristics of tagged juvenile fish at the Lower Granite Dam in the Snake River and how they relate to hydrosystem operations. It includes monitoring in the estuary to improve estimates of survival to Bonneville Dam.

Methods: Approximately 50,000 (total) hatchery steelhead, wild steelhead, and wild yearling Chinook salmon are tagged at the Lower Granite Dam on the Snake River. Additionally, detections of other fish tagged upstream of Lower Granite Dam and other sites on Snake and Columbia rivers are included. The project uses standard Cormack-Jolly-Seber capture-recapture methods to estimate hydrosystem survival through dams and the estuary. Travel time estimates are also provided from Lower Granite Reservoir to Bonneville Dam. A trawl with a PIT-tag antenna is also used in the estuary. The relationship between detection from the trawl and flow is investigated using standard regression methods. The methods have been reviewed extensively by the ISAB.

Program Relevance and Project Results: The project performs critical research on the impact of flows and other hydrosystem operations on fish passage survival. Relationships between survival and migration conditions were evaluated, and it was concluded that survival improves with spillway passage. This result prompted a spill experiment that was proposed a few years ago.

A PIT tag antenna mounted on a trawl is used to detect and estimate the survival of PIT-tagged fish in the estuary. Trawl detections for yearling Chinook and steelhead were deemed adequate to make survival estimates. More detections, however, are needed on juvenile sockeye and sub-yearling Chinook to estimate their residence timing and survival in the estuary.

Substantial mortality is occurring upstream from the Snake and Clearwater River confluence. Additional instream PIT-tag monitors are needed to determine where this mortality is occurring.

High rates of spill and use of surface-bypass structures has reduced PIT-tag detection rates at dams and reduced precision of survival estimates. Development of PIT-tag detectors for spillways is needed to improve estimates of survival.

This project could provide data to look at the effects of density dependence in the mainstem as smolts travel the hydrosystem. Additional data, however, on the total number of smolts migrating with the tagged smolts would be required.

Broad Applicability: Projects considering all stocks migrating through the hydrosystem use the results from these studies.

Time Required: This is the 22nd year of this study. Every year, reports are updated with previous years' results. This is a long-term monitoring project that will continue on indefinitely to show that the dams are meeting performance standards.

200500200 - Lower Granite Dam Adult Trap Operations

Links to: project **and** reports

Proponent: National Oceanic and Atmospheric Administration

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?

Comment:

This project does not do evaluations and indirectly addresses critical uncertainties by providing data for other research projects.

Methods: This project strictly collects and monitors adult salmonids migrating past Lower Granite Dam (LGR). The adult trap at the dam is operated from March through November and collects 5 to 20% of the fish passing the dam. Some of these fish are used for broodstock at Snake River hatcheries. The trapping operation is also used to collect data for run reconstruction, detect previously PIT-tagged adults, collect steelhead for PIT tagging, and to collect adult salmon previously radio tagged.

Program Relevance and Project Results: All the data obtained by the project are passed on to other projects, which may ultimately address High Level Indicators. In 2014, when the trap sampled 8 to 10% of the run, over 10,000 fall Chinook were collected. Of these, about 4,000 were sent as broodstock to the Lyons Ferry Hatchery and the Nez Perce Hatchery.

Broad Applicability: Data derived from this project may help evaluate salmonid recovery efforts above Lower Granite Dam. Those evaluations, however, will take place outside of the project.

Time Required: The project has been in place for 10 years and, as a monitoring project, will continue for the foreseeable future.

200304100 - Evaluate Delayed (Extra) Mortality Associated with Passage of Yearling Chinook Salmon through Snake River Dams

Links to: project **and** reports

Proponent: National Oceanic and Atmospheric Administration

2006 Research Plan uncertainties addressed:

Direct:

- Mainstem Hydrosystem Flow and Passage Operations: Under what conditions is delayed mortality related to downstream migration through the hydrosystem, and what is the magnitude of that delayed mortality?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?

Comment:

The project compares the smolt-to-adult survival rates (SARs) of spring Chinook originating from experimental groups that are captured and tagged at the Lower Granite Dam. Covariates such as spill and other variables are collected to try and explain any differences in response variables.

Methods: The project compares SARs of three groups of spring Chinook salmon. One group consists of fish PIT-tagged at Lower Granite Dam (LGR) and then trucked and released below Ice Harbor Dam. A second group, also tagged at the dam was trucked and then released at LGR (reference treatment). The third group of PIT tagged fish is released directly from LGR (trucking effect). Based on a power analysis, 120,000 fish were released each year (2005 thru 2011). Fish that survive to McNary Dam (i.e., detected there) will be used in the SAR analyses. Adult returns to Bonneville Dam were completed in 2014.

Program Relevance and Project Results: This is the last year of the study with a full data analysis planned for this year. In a previous report the reported SAR ratio of 0.93 (95% confidence interval of 0.80 - 1.08) for the 2008 releases, which suggests that there was no evidence of a difference in SARs of dam passage / reference groups.

The project is very relevant to hydropower operations and will help address the question of whether or not dam passage leads to delayed mortality of smolts. Project results will compare effects of eight dams to effects of five dams, but does not consider fish that migrate through the hydropower system and are never detected at any dam--i.e., migrate completely via spill or turbine passage at dams.

Although, as the project proponents acknowledge, no experimental design can simulate migration through a free-flowing Snake River, the results of the study will either support the hypothesis that survival is decreased by migration through the three lower dams and reservoirs, or fail to support an effect large enough to be detected, given the power of the tests.

Broad Applicability: The study applies to all of the dams in the hydrosystem and may have applicability for other species of salmonids. However, this applicability would have to be validated for each species of concern.

Time Required: The project will end this year (2015) with the analysis and reporting on all years of data.

199102800 - PIT Tagging Wild Chinook

Links to: project **and** reports

Proponent: National Oceanic and Atmospheric Administration

Province/subbasin: Mountain Snake/Salmon

2006 Research Plan uncertainties addressed:

Direct:

- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?

Indirect or Potential:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Can a new survival model be developed to effectively incorporate data collected from instream PIT tag monitoring sites, given the problem of a lack of independence in detections of a fish between multiple PIT tag-arrays on the same stream?

Comment:

The authors of the report state (p. 9 and 43) that there is a need for new survival models appropriate for data collected from instream PIT tag monitoring sites. The problem is a lack of independence in detections of a fish between multiple PIT tag-arrays on the same stream. For example, a fish detected at one array is more likely to be detected on a second array than a fish not detected at the first array. Small sample sizes also lead to estimates with large uncertainty and experiments with low power to detect effects. A Bayesian approach may be fruitful here where information from multiple small studies share information about a common effect.

Methods: In 2013, about 12,000 Wild Chinook salmon parr were PIT tagged and released into Snake River tributaries located in Idaho and Oregon. Water temperature and depth were measured at 15 locations in the Salmon River Basin. In 2012-13, the project compared PIT tag detection efficiencies for 12-mm and 9-mm tags. Detection rates were not significantly different between the two types of tags at Lower Granite Dam. The project uses the Cormack-Seber-Jolly method for estimating survival of wild parr tagged in 16 streams in the Snake River Basin that migrate to Lower Granite Dam (LGR) based on instream PIT-tag monitors and the PIT-tag array at LGR and downstream.

Program Relevance and Project Results: *S*urvival estimates for parr spring/summer Chinook tagged as parr in 16 to 19 upper reaches of Snake River tributaries to Lower Granite Dam are reported. Survival varied from ~8% to ~24% from 1993 to 2013. It appeared that survival is negatively correlated with parr density. Fish detected at LGR were significantly larger at the time of tagging than were fish that were not detected at LGR. Fish detections at LGR were greatest when flows in the Snake River peaked. Estimates of the mean passage dates at LGR from each stream based on 15-25 years of data are also presented.

Broad Applicability: The project is applicable to the Snake River Basin. The methods developed however, (PIT-tagging, data analyses) may be applicable to other species or to spring/summer Chinook in other subbasins. The information can help with recovery planning that will be impacted by climate change.

Time Required: The project has been in place since 1991, and it will probably continue in order to track recovery of wild fish in the Snake River basin.

198910700 - Statistical Support for Salmon

Links to: project **and** reports

Proponent: University of Washington

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?
- Population Structure and Diversity: What are the differential effects of flow augmentation, transportation, and summer spill on "ocean type vs. reservoir type" fall Chinook?

Comment:

The relationship of the project to the uncertainties listed above is indirect because it maintains and develops software used for analysis of capture-recapture data from PIT tags and other tag types.

Methods: The computer programs use standard likelihood statistical methods for the analysis of capture-recapture data using PIT tags and other tag types. Sample size/power analyses programs for planning studies in tributaries were also developed. Reviews of other proposals (e.g. the spill experiment) were also performed. This methodology has been reviewed in published papers and by the ISAB and ISRP numerous times.

Program Relevance and Project Results: These statistical methods are used throughout the watershed when tagging studies are conducted. The focus of this software support is using likelihood methods, but Bayesian methods are becoming increasingly used and important for combining results from many small studies or for projects that produce data that are too complex for standard likelihood methods (e.g. hierarchical survival models over multiple release groups). So far the project has not developed any software that employs Bayesian methods.

Broad Applicability: Software suites are developed to avoid custom-made code for individual projects. For example, the SURPH program is used for instream survival analysis, TribPIT is used for planning tributary studies using PIT tags, and BRANCH is used for route specific survival over dams using PIT tags.

Time Required: Very short time frames apply to simple projects, while ongoing development/support for software is longer time frame. The actual center will continue into the foreseeable future.

199601900 - Data Access in Real Time (DART)

Links to: project **and** reports

Proponent: University of Washington

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat Estuary, Plume and Ocean: What specific factors affect survival and migration of species and life-history types of fish through the estuary, and how is the timing of ocean entry related to subsequent survival?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?

Comment:

The project provides database, data repository, data report, and analysis services in support of analyses that examine the effects of hydrosystem operations on fish movement, mortality, travel time, etc. Thus it is indirectly associated with the uncertainties shown above.

Methods: The project provides a second-tier database, a data repository, data reporting, and analysis services for use by agencies in the Columbia system. It stores Columbia Basin environmental, operational, fishery, riverine, ocean, and climatic data.

Program Relevance and Project Results: The project collects data from over 20 federal, state and tribal databases to provide a regional information tool. It has many deliverables. For example, it provides real time reporting on (tagged) fish as they move through the hydrosystem along with historical reporting on passage dates. DART also provides analytical processing tools of PTAGIS interrogation data from instream tributary PIT-tag arrays so that movements and life history patterns of individual fish can be observed in greater detail. It efficiency handles and standardizes analysis of datasets which allows comparable, reproducible results across research studies. DART provides status measures for numerous stocks through summary statistics, trends, reach and system survivals, migration patterns, and exposure indices monitored on a daily basis throughout the year. It also reports stream flows, ocean conditions, and long-term climate trends. Specialized data aggregation and queries provide passage, travel time, and survival information on juvenile and adult ESA-listed PIT-tagged stocks. Over 600,000 queries in a typical year are processed in real time. DART staff also provide specialized data requests and analyses as needed.

Broad Applicability: The DART database and its analytical tools can be tailored to meet a variety of different queries and user requirements.

Time Required: Queries are typically run in real time. Database loading from outside agencies is dependent on co-operation from the other agencies. This product will likely continue for the foreseeable future.

199105100 - Modeling and Evaluation Statistical Support for Life-Cycle Studies

Links to: project **and** reports

Proponent: University of Washington

2006 Research Plan uncertainties addressed:

Direct:

- Mainstem Hydrosystem Flow and Passage Operations: Under what conditions is delayed mortality related to downstream migration through the hydrosystem, and what is the magnitude of that delayed mortality?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?

Indirect or Potential:

- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Population Structure and Diversity: What are the differential effects of flow augmentation, transportation, and summer spill on “ocean type vs. reservoir type” fall Chinook?

Comment:

The project provides data analysis, evaluation of life-history performance, and guidance on design and analysis of monitoring and evaluation studies. Some of the work products produced directly address specific uncertainties about delayed mortality, survival, and transport effects.

Methods: The project provides in-season projections of smolt-outmigration timing to assist in spill management. Standard statistical methods are used to estimate timing of outmigration; relationships between flow and survival; and performance measures on survival, water temperature, etc. These methods have been extensively reviewed by the ISAB.

Program Relevance and Project Results: The project has provided in-season estimates of smolt-outmigration timing for more than 50 different fish stocks to assist in spill management for over 20 years. It also provides statistical analyses of historical tagging data to understand the relationships between fish responses, environmental factors, and anthropogenic effects. Performance measures such as adult passage counts, compliance with flow targets, compliance with temperature targets, and compliance with total dissolved gas (TDG) were uploaded to the DART system.

Broad Applicability: The data and analyses provided by the project are used by many groups.

Time Required: This project has been ongoing for over 20 years and will likely continue for the foreseeable future.

200851800 - Upstream Migration Timing

Links to: project **and** reports

Proponent: Columbia River Inter-Tribal Fish Commission (CRITFC)

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, in-river return rates, and measurements of juvenile survival (D values)?

Comment:

This project indirectly addresses the above uncertainties by collecting data on adult salmon as they migrate through the mainstem Columbia and some tributaries. These data can be used along with abiotic environmental data to explore the effects of mainstem hydrosystem operations on fish survival.

This project should be linked to the Snake River Fall Chinook Monitoring and Evaluation Project (#2012-013-00) as both are doing similar work.

Methods: Since 1985, the project has collected data on migration rates, escapement, fallback, and distribution into large tributaries of adult Chinook, sockeye, and steelhead (since 2004) PIT tagged at Bonneville and detected at upstream dams. While the methods appear sound, it seems that more analyses could be accomplished with the data. For example, analyses of dam operations (e.g., flow, spill) or water temperature might explain differences in the variables being assessed. The original proposal said that Genetic Stock Identification (GSI) was going to be used to identify stocks, but it apparently did not happen. It is not clear if having complete life cycle information is an objective of this project.

Program Relevance and Project Results: The project provides valuable data on the migration of adult salmonids into the Columbia Basin. The project, for example, has documented that various salmonid species originate in different parts of the Basin e.g., ~82% of adult sockeye return to the Okanogan, ~18% to the Wenatchee and < 1% return to the Snake River subbasin. The project findings were used in at least one instance to manage adaptively the adult trap at Tumwater Dam. Based on project findings that sockeye were taking over 4 days to pass the dam, the trap operation schedule was adjusted and the mean time was reduced to 6 minutes. A complete assessment of the precision and accuracy of stock specific escapement and survival estimates would be a valuable addition to the findings.

Broad Applicability: The project addresses movement of adult salmonids throughout the Columbia Basin. It appears that data on the fish they tag are also used by other projects, especially tracking adults after they enter smaller tributaries such as the John Day and Deschutes Rivers. In 2012, the project tagged a portion of the fish with the 9-mm PIT tag, and although the sample size was small, it appeared that adults with smaller tags were detected at a lower rate than those with the standard 12-mm tag. This is good information for those tagging juvenile salmonids--especially wild fish.

Time Required: The project has been in place since 1985 and will probably continue as it provides managers with information that can be used to adaptively manage the hydrosystem.

200890800 - FCRPS Water Studies & Passage of Adult Salmon & Steelhead

Links to: project **and** reports

Proponent: Colville Confederated Tribes

2006 Research Plan uncertainties addressed:

Direct:

- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- For adult salmon monitoring, given the very large sample sizes needed for PIT-tagged juveniles, perhaps other methods can be considered such as genetic stock identification of some returning adults with new tags added at the adult stage rather than at the juvenile stage?

Comment:

The project provides direct information on the impact of dam passage on adult conversion or survival rates. It directly addresses the second question listed in the second uncertainty (*"Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration?"*). The other three uncertainties in this question are indirectly addressed.

Methods: This project focuses on addressing the question as to why salmon and steelhead adults returning to the Upper Columbia River (UCR) have poorer survival (referred to as "conversion") than do adults returning to the Snake River (SR).

PIT-tagged juveniles of known origin that were known to have migrated in-river (not transported) and were detected at Bonneville (BON) as adults (not jacks) were used. Observed detections at McNary Dam (MCN) or higher give the product of survival from BON to MCN and detection at MCN or higher. Adjustments to the data were made to account for in-river harvest and straying.

Other tasks in the project included literature surveys on specific issues affecting adult salmon migration, developing and implementing a monitoring plan to address factors limiting UCR adult survival and increasing the number of PIT tags put into juvenile salmonids in the UCR.

Program Relevance and Project Results: This project provides quantitative biological data on the survival of UCR and SR steelhead and salmon adults migrating pass the lower Columbia River dams**.** Using the original version of this model, SR steelhead and spring Chinook survived about 5% more than did UCR fish. After adjusting for in-river harvest and straying, estimated survival rates of steelhead and salmon increased for all groups but were still 5% apart comparing SR to UCR fish.

There are still knowledge gaps concerning the use of thermal refuges for steelhead and harvest rates for Chinook that probably explain the large difference seen in survival estimates when using unadjusted and adjusted data.

The design of a monitoring plan to investigate the factors limiting adult survival in the lower river suggested that 3,000 to 6,000 adults of each group are needed to address the question. This is far larger than the number currently available indicating that substantially more juvenile fish need to be PIT-tagged.

Broad Applicability: The study is looking at mortality of steelhead and spring Chinook salmon adults migrating through the lower Columbia River dams. If they find limiting factors, these should also apply to other species and to lower river migrants as well.

Time Required: The project has been in place since 2008 and will probably continue until limiting factors are elucidated.

199900301 - Evaluate Spawning of Fall Chinook and Chum Salmon Just Below the Four Lowermost Mainstem Dams

Links to: project **and** reports

Proponent: Oregon Department of Fish and Wildlife, Pacific Northwest National Laboratory, Pacific States Marine Fisheries Commission, Washington Department of Fish and Wildlife (WDFW)

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: What are the impacts of hydrosystem operations on mainstem habitats, including the freshwater tidal realm from Bonneville Dam to the salt wedge? How might hydrosystem operations be altered to recover mainstem habitats?

Indirect or Potential:

- Mainstem Hydrosystem Flow and Passage Operations: What are the optimal temperature and water quality regimes for fish survival in tributary and mainstem reaches affected by dams, and are there options for hydrosystem operations that would enable these optimal water quality characteristics to be achieved? What would be the effects of such changes in operations and environment on fish, shoreline and riparian habitat, and wildlife?
- Mainstem Hydrosystem Flow and Passage Operations: What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species and stocks? What are the ecological effects of hydrosystem operations on downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- How important are mainstem habitats from McNary Dam to an area just downstream of the Bonneville Dam to chum and fall Chinook salmon production?
- What water flows, velocities, elevations, and temperatures are necessary to ensure the survival of fall Chinook and chum salmon adults, eggs, fry, and juveniles immediately below Bonneville Dam?
- What are the annual abundance levels of chum salmon and fall Chinook salmon spawning below Bonneville Dam?
- How many temperature units are required for chum salmon emergence in spawning areas just below Bonneville Dam, i.e. those located adjacent to Ives and Pierce Islands?
- Do chum salmon cease spawning at night?

Several additional uncertainties that the project could potentially consider are:

- Adult chum salmon annually pass over Bonneville Dam. Are these fish straying or homing to undiscovered spawning areas above the dam?
- Can existing project data on the effects of water height, flow, velocity, and temperature on chum and fall Chinook salmon be used in a model to regulate hydrosystem operations to ensure that suitable spawning, incubation, and juvenile rearing conditions exist for these species below Bonneville Dam?

Comment:

The project addresses portions of the three 2006 Research Plan uncertainties listed above.

In the first uncertainty the project does look at hydrosystem impacts on mainstem spawning areas used by chum and Chinook salmon just downstream of the Bonneville Dam. Alterations in hydrosystem operations are being made to accommodate natural spawning, incubation, and early juvenile rearing in mainstem areas just downstream of the Bonneville Dam for these two species. How hydrosystem operations may affect other aspects of mainstem habitat (e.g. rearing habitat, food production, etc.) for salmonids and other fishes are not addressed.

The second listed uncertainty is also partially addressed. The project collects real-time data on water elevations, temperature, and flow to ensure that suitable spawning, incubation, and rearing conditions for chum and Chinook exist in the immediate area below Bonneville Dam. No effort, however, appears to be made to determine optimal water conditions for different species in tributaries and other parts of the mainstem. Additionally, the project is not investigating how hydrosystem operations might be altered to create such conditions. Thus, the effects of such potential actions on fish, wildlife, shoreline, and riparian habitats remain unexplored.

A minor portion of the third uncertainty, flow characteristics on channel features, is touched on by the project. As mentioned above, flow characteristics are monitored and adjusted as needed to create and maintain spawning and incubation areas just below Bonneville Dam. Other aspects of this uncertainty were not examined by the project.

Additional uncertainties not mentioned in the 2006 Research Plan were investigated and are listed above.

Methods: Appropriate standard and innovative methods were used to assess the locations of spawning areas, population abundance, stock origin, demographic profiles, and the effects of flows, temperatures, and water levels on chum and fall Chinook salmon spawning below the four lowermost dams on the Columbia River. Results were typically presented as point estimates. Raw data were often attached to the annual reports in appendices. Accuracy and precision were not reported. Findings from some of the work reported have been published in the peer-reviewed literature suggesting that the methods used met scientific criteria.

Program Relevance and Project Results: Currently the project provides information on the abundance of fall Chinook and chum salmon spawning below Bonneville Dam and real-time information on water levels, flows, and temperature regimes in spawning areas below the dam. The flow, water level, and temperature data are used by managers to regulate water releases from Bonneville Dam to ensure downstream conditions are suitable for spawning and incubation.

The project tracks the abundance of chum and fall Chinook spawning below Bonneville Dam, and these data can be used to track yearly variation in abundance. Age, stock origin, and hatchery/wild composition of spawning adults are estimated from samples obtained from carcasses and live fish. This work is largely restricted to the area adjacent to Ives and Pierce Islands that are located just below Bonneville Dam.

The project estimates the yearly abundance of chum and fall Chinook salmon spawning below Bonneville Dam (high level indicator—Abundance of Fish and Wildlife). As indicated above, data on flow, water height, and temperatures are being used to regulate water releases from Bonneville to protect spawning, incubating, and rearing salmon. This is an example of how information derived from the project was and is being used in adaptive management.

Broad Applicability: Results of the project are being used to help assess the status of Lower Columbia River chum salmon which were listed as threatened under the ESA in 1999. Three methods of estimating adult abundance (area under the curve, live mark-recapture, and a carcass mark-recapture procedure called the Worlund Method) are being used and could be exported to other projects. Several other methods being used by the project may also have broad applicability, e.g. underwater video assessments of deep water spawning; DIDSON Sonar for examining behavioral responses during spawning to changes in water velocity and depth due to hydropower operations; LASER and video records for estimating substrate size at spawning locations; real-time data collection on water heights, flows, and temperatures; and the use of two otolith marking techniques one using temperature shifts to create bar codes and another that uses short exposure to strontium baths (< 4 hr) to produce detectable strontium bands.

Time Required: Project results have been reported in a timely fashion. The project will continue into the foreseeable future because it is monitoring adult abundances of chum and fall Chinook salmon and flow conditions below Bonneville Dam.

Adequacy of Reporting: This project started in 1998 and researchers from five agencies (ODFW, USGS, PNNL, PSMFC, WDFW) have conducted various parts of the project. No summary document for the project apparently exists. It would be very informative if each agency could produce a manuscript with their research questions, methods, and findings. These reports could be placed into a single document that reviews what has been discovered to date.

Anadromous Fish Evaluation Program (AFEP) Passage Studies

Presentation	Title
AFEP 2014-01	Conversion of radio-tagged adult Chinook salmon and steelhead through the Federal Columbia River Power System (FCRPS), 2013-2014
AFEP 2014-02	Evaluation of adult salmon and steelhead passage behavior and success in relation to fishway modifications at Bonneville Dam
AFEP 2014-03	Evaluation of adult salmon and steelhead passage behavior in relation to fishway modifications at The Dalles and John Day dams, 2013-2014
AFEP 2014-05	Overwintering distribution and behavior of adult steelhead in the FCRPS, 2013-2014
AFEP 2014-06	McNary Dam Adult Steelhead Direct Survival Study
AFEP 2014-07	Adult Steelhead and Chinook salmon passage, survival, and conversion through the lower Snake River. New adult PIT detection efficiencies.
AFEP 2014-09	Migration Timing and Survival of PIT-tagged Adult Salmonids from the Columbia River Estuary to Bonneville Dam, 2014
AFEP 2014-10	Lower Granite Dam Juvenile Fish Collection Channel Prototype Overflow Weir and Enlarged Orifice Biological Evaluation, 2014
AFEP 2014-11	Lower Granite Dam Juvenile Fish Collection Channel Prototype Overflow Weir and Enlarged Orifice: An Evaluation of Fish Injury and Subsequent Survival
AFEP 2014-12	Juvenile Bypass System Selectivity at FCRPS Dams
AFEP 2014-17	Methods and Overview for Compliance Study Assessment of Juvenile Salmonids at McNary and John Day Dam's, 2014
AFEP 2014-18	Results of 2014 Survival Compliance Studies at McNary and John Day Dams
AFEP 2014-19	2013 Little Goose Summer Juvenile Salmon Dam Passage Performance Standard Route Survival Diagnostics
AFEP 2014-20	JSATS Tag development for juvenile salmon, sturgeon, eel, and lamprey
AFEP 2014-21	Pit-Tag reach survival estimates, 2014
AFEP 2014-22	Growth of Smolts Between Lower Granite and Bonneville Dams
AFEP 2014-23	Detection of PIT-Tagged Juvenile Salmonids Using a Surface Pair-Trawl in the Columbia River Estuary, 2014
AFEP 2014-24	Determine the Seasonal Effects of Transporting fish from the Snake River to optimize a Transportation Strategy.
AFEP 2014-25	Fall Chinook Transportation Evaluation
AFEP 2014-26	Analysis of straying rates and behaviors of Snake and Columbia River salmon and steelhead
AFEP 2014-27	Depth Distribution of Migrating Yearling and Subyearling Chinook Salmon and Juvenile Steelhead In the Snake River

Overview of 21 Studies from 2014 AFEP Conference

The table above lists study presentations from the 2014 Annual Research Conference for the U.S. Army Corps of Engineers' Anadromous Fish Evaluation Program. This overview provides a snapshot of AFEP efforts and is *not* intended to be a comprehensive analysis of AFEP.

2006 Research Plan uncertainties addressed:

Direct:

- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- AFEP-12 showed that the juvenile bypass system tended to select fish in poorer condition compared to fish that use the spillway/turbine. Because the juvenile bypass system is used to select fish for transport, this may explain some of the effect of transport (e.g. delayed mortality).

Comment:

These projects complement other studies in the basin by focusing on specific performance aspects. There are several classes of studies. First, the behavior of returning adult fish as they pass upstream through the hydrosystem is monitored, often using radio-tagged adult fish. Conversion or survival rates of adults were estimated (AFEP-01) using radio-tagged fish (rather than relying on returning adults who were PIT tagged as juveniles). This enables the use of a larger sample size at the cost of not being able to identify the source of the adult fish. Genetic Stock Identification methods could be useful here to identify the stock origin of radio-tagged adults. Radio telemetry allows identification of where the fish move with greater certainty than PIT tags and detection arrays are not needed in tributary streams. Similarly, overwintering behavior, fall back, and straying of adults were monitored (AFEP-05, AFEP-26)

Several studies evaluated specific hypotheses at individual dams. For example, do changes to dam configuration change the behavior of returning adult fish (AFEP-02, AFEP-03). What is the survival of adult steelhead that pass through turbines (AFEP-06)? And what is the impact of improved PIT tag arrays on detection rates at several adult ladders (AFEP-07).

Second, studies were performed on juvenile fish. Questions such as: (a) Can PIT tagged juvenile fish be reliably detected in the estuary (AFEP-09, AFEP-23)? (b) What are the impacts of new passageways at dams (AFEP-10, AFEP-11) on juvenile survival? And (c) Are juvenile bypass systems selecting juveniles at random (AFEP-12) being addressed? Acoustic tags are being used to determine if dam passage survival rates for yearling Chinook are at least 96% (AFEP-17, AFEP-18, AFEP-19). Survival rates for juvenile salmonids are also being estimated for individual reaches of the hydrosystem. Additionally, estimates of the fraction of juvenile salmonids that are being transported through the hydrosystem and the effects of transport are being made (AFEP-21, AFEP-22, AFEP-24, AFEP-25).

Finally, one study evaluated potential new tags for salmon, sturgeon, and lamprey (AFEP-20)

Project Results: Most of these studies provide results that are specific to an individual dam, but lessons learned at one dam do provide some information about future modifications at other dams. There are some results of general interest.

AFEP-12 showed that juvenile bypass systems tend to select fish in poorer condition compared to fish that use spillway/turbine dam passage routes. Because the juvenile bypass system is used to select fish for transport, this may explain some of the effect of transport (e.g. delayed mortality) on juvenile salmonids.

AFEP-20 found that entire hydrosystem survival (Snake River to Bonneville) of juvenile Chinook salmon was about 50% similar to past years. This implies that the system has been fairly consistent in moving fish downstream in recent years.

Coded Wire Tag

198201301	Coded Wire Tag-Pacific States Marine Fisheries Commission (PSMFC)	Pacific States Marine Fisheries Commission
198201303	Coded Wire Tag-US Fish and Wildlife Service (USFWS)	US Fish and Wildlife Service (USFWS)
198201304	Coded Wire Tag-Washington Department of Fish and Wildlife (WDFW)	Washington Department of Fish and Wildlife (WDFW)
201003600	Lower Columbia Coded Wire Tag (CWT) Recovery Project	Washington Department of Fish and Wildlife (WDFW)
200850200	Expanded Tribal Catch Sampling	Columbia River Inter-Tribal Fish Commission (CRITFC)
200206000	Nez Perce Harvest Monitoring on Snake and Clearwater Rivers	Nez Perce Tribe
200810500	Selective Gear Deployment	Colville Confederated Tribes

Summary

The four coded-wire tag (CWT) projects collect, interpret, and report data for stock assessment but do not directly test hypotheses related to uncertainties. Most CWT's are applied to hatchery fish, and an uncertainty is the degree to which the tagged hatchery fish represent associated natural salmon. Parent Based Tagging (PBT) and more traditional Genetic Stock Identification may eventually provide a better approach for addressing questions related to natural salmon.

The selective fishery project by the Colville Confederated Tribes directly addressed two critical uncertainties: 1) Is it possible to reduce density dependence and introgression associated with hatchery fish spawning in streams by selectively removing fish? And 2) Can hatchery origin adults be harvested by tribal members while minimizing negative impacts on natural populations? The Colville project identified several key selective gears (purse seine, weir, and beach seine) that can be used to collect adult salmon. Additional work, however, is needed to evaluate the effects of these live-capture methods on natural Chinook salmon that are caught and subsequently released. The project findings have broad applicability in the Basin, if other fishing groups can be encouraged to use selective fishing techniques.

The two tribal catch monitoring programs provide more accurate catch estimates, which are important, but they do not directly address critical uncertainties related to harvests.

198201301 - Coded Wire Tag-Pacific States Marine Fisheries Commission (PSMFC)

Links to: project **and** reports

Proponent: Pacific States Marine Fisheries Commission

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?

Comment:

Harvest uncertainty: The project manages the coded wire tag database that is used primarily by the Pacific Salmon Commission, the Pacific Fishery Management Council, the North Pacific Fishery Management Council, and state and tribal fisheries agencies to estimate stock composition and catch/bycatch of Columbia River salmonids in mixed-stock fisheries and on the spawning grounds. The project does not directly test hypotheses using these data, but many other projects do.

Methods: This long-term PSMFC project uses sound methods, and the level of accuracy and precision of the data and/or analyses reported is generally high for the stocks that are tagged. Most CWT fish are from hatcheries and managers generally assume that hatchery stocks are representative of natural stocks. The increasing use of Parent Based Tagging and recent refinements in Genetic Stock Identification will allow this assumption to be tested and will also provide a way to estimate the proportion of wild fish present in harvests.

Program Relevance and Project Results: The project is relevant to research, status and trend M&E, and project level monitoring (https://pisces.bpa.gov/release/documents/DocumentViewer.aspx?doc=P142266). The CWT database provides information for monitoring and evaluating population characteristics of Columbia River Basin hatchery and wild salmon and steelhead and for monitoring the status of ESA-listed stocks. Metrics include stock of origin, hatchery versus wild origin, smolt to adult survival, age, adult size, etc. The project also provides information for evaluating stock-specific contributions to ocean and in-river fisheries, information needed for management and conservation of Columbia River stocks.

Broad Applicability: CWT data are used by many other projects and programs

Time Required: This is a long-term project that will likely continue as long as coded-wire tags are used to estimate stock composition of salmonids in mixed-stock fisheries and on the spawning grounds. The project reported results in a reasonable amount of time.

198201303 - Coded Wire Tag-US Fish and Wildlife Service (USFWS)

Links to: project **and** reports

Proponent: US Fish and Wildlife Service (USFWS)

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?

Comment:

Harvest Uncertainty: The project tags coho and Chinook salmon from each USFWS hatchery, provides release data to the Pacific States Marine Fisheries Commission, and prepares an annual stock assessment report of release and recovery information for each species, stock, and brood year. The project does not directly test hypotheses using these data.

Methods: This USFWS project uses sound methods. The level of accuracy and precision of the data and/or analyses reported is generally high (https://pisces.bpa.gov/release/documents/DocumentViewer.aspx?doc=P131516). All fish release information, including marked/unmarked ratios, is reported to the Pacific States Marine Fisheries Commission (PSMFC). Fish recovered in the various fisheries or at the hatcheries are sampled to recover coded-wire tags. This recovery information is also reported to PSMFC.

Program Relevance and Project Results: The CWT data generally help with tracking status and trends in hatchery salmon harvests and survival. The scale of the effort is basinwide and includes ocean harvests. Metrics include the following information for each brood year, species, hatchery, and life stage released at the hatchery, release information including numbers and mean size, the total number of observed recoveries, where recoveries occurred, the number of expanded recoveries from the PSMFC TS1 report, the number of recoveries expanded to include unmarked fish released, and a summary of where fish were recovered.

Broad Applicability: The project has broad applicability, as CWT data are used by many other projects and programs. In this project, CWT recovery information is used to evaluate the relative success of individual hatchery brood stocks. This information can also be used by salmon harvest managers to develop plans to allow the harvest of excess hatchery fish while protecting threatened, endangered, or other stocks of concern.

Time Required: This is a long-term project that will likely continue as long as coded-wire tags are used to estimate stock composition of salmonids in mixed-stock fisheries and on the spawning grounds. The time required for stock assessment reporting seems to be about two or three years, as the most recent annual report on the BPA website is for 2011 (submitted in 2013).

198201304 - Coded Wire Tag-Washington Department of Fish and Wildlife (WDFW)

Links to: project **and** reports

Proponent: Washington Department of Fish and Wildlife (WDFW)

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?

Comment:

Harvest Uncertainty: The project collects and manages WDFW coded wire tag release and recovery data that is provided to the Pacific States Marine Fisheries Commission project. The project does not directly test hypotheses using these data.

Methods: This WDFW project uses methods that are well-established, sound, and statistically reliable.

Program Relevance and Project Results: The project is relevant at basinwide scales and in the ocean for both research and status and trend M&E (https://pisces.bpa.gov/release/documents/DocumentViewer.aspx?doc=P139971).

Broad Applicability: The results have broad applicability at basinwide and ocean scales, providing a long and consistent time series of survival and distribution data that can be used to measure trends in abundance of selected hatchery stocks and data relevant to the management of natural stocks.

Time Required: This is a long-term project that will likely continue as long as coded-wire tags are used to estimate stock composition of salmonids in mixed-stock fisheries and on the spawning grounds. The time required for reporting seems to be about three years, as the most recent annual report is for 2012 (dated 2014).

201003600 - Lower Columbia Coded Wire Tag (CWT) Recovery Project

Links to: project **and** reports

Proponent: Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Columbia Gorge/Columbia Gorge, Columbia River Estuary/Columbia Estuary, Lower Columbia/Columbia Lower

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?

Comment:

Harvest Uncertainty: The project recovers coded wire tags (CWT), PIT-tags, and marked salmonids from lower Columbia River fisheries and spawning grounds, and uses the data to estimate escapement primarily for Chinook. The project reports Viable Salmonid Population (VSP) metrics for Chinook and coho salmon, and provides these data to policy makers, planners, managers, and others. Coded-wire tag recovery data are provided to the Pacific States Marine Fisheries Commission project. The project does not directly test hypotheses using these data.

Methods: The description of methods in the latest annual report (https://pisces.bpa.gov/release/documents/DocumentViewer.aspx?doc=P142594) is insufficient to evaluate whether they are sound and yield statistically reliable results. The level of accuracy and precision of the data and/or analyses are not reported.

Program Relevance and Project Results: This project is important for monitoring listed Chinook and coho populations, which includes CWT recovery along with escapement, diversity, and spatial structure estimates, in Washington's Lower Columbia River Evolutionary Significant Unit and at Hanford Reach. The project's run reconstruction is used to evaluate past fishery and conservation actions and to provide mangers a forecast for fishery and conservation planning for the following year. The project also samples fisheries in the mainstem Columbia River and tributaries for CWTs and marks, and samples for PIT tags and does viable salmonid population monitoring in tributaries below Bonneville Dam. Accurate escapement estimates would reduce uncertainties in FWP High Level Indicators.

Broad Applicability: The results have widespread applicability to salmonids and fisheries in the lower Columbia River.

Time Required: This is a long-term project that will likely continue as long as artificial tags (CWT, PIT) and physical marks are used for stock assessment of salmonids in the lower Columbia River. Annual reporting is on time and up to date.

200850200 - Expanded Tribal Catch Sampling

Links to: project **and** reports

Proponent: Columbia River Inter-Tribal Fish Commission (CRITFC)

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?

Comment:

This project is designed to improve catch reporting in the Zone 6 tribal fishery. Tribal creel data are used by the Yakama Nation Fisheries Department to generate total catch estimates for the tribal fishery. These estimates are necessary to ensure fisheries are managed within the limits of the 2008-2017 U.S. v. Oregon Management Agreement. This project might seem to address the uncertainty associated with harvest estimates, but the annual report states, “This project was not designed to assess or investigate anything that might be characterized as a ‘critical uncertainty’ related to harvest estimates or harvest management practices."

Methods: This project uses a creel survey to estimate CPUE and an aerial survey to estimate effort for one component of the tribal fishery. The project also has fish tickets to cross check reporting, but this has not been implemented. Creel surveys can be used effectively to estimate catch if proper sampling designs are used. PIT tags are collected but are not used for management. The U.S. v. Oregon Technical Advisory Committee (TAC) review and distribute harvest data for Zone 6 (Bonneville-McNary) mainstem treaty fisheries. These reports and data are available at: http://www.dfw.state.or.us/fish/OSCRP/CRM/reports.asp

This project is designed to improve the monitoring and catch sampling of the Zone 6 tribal fisheries by increasing the collection of more tribal catch data through increased sample rates and employing the use of additional data collection methods. In general, the creel monitors try to sample at least 20% of the landed catch. This goal was achieved.

Program Relevance and Project Results: There is a substantial Chinook harvest in the fall fishery that is relevant to sustaining these populations. The proponents present data for catch summaries but not a breakdown on harvest by sector.

Broad Applicability: It is important to record harvest of stocks migrating to areas throughout the Basin. This effort contributes to the overall objective of documenting harvests in Zone 6.

Time Required: The creel survey is executed in a timely fashion. Data analyses can be completed in less than a year on existing data. Harvest monitoring should continue indefinitely.

200206000 - Nez Perce Harvest Monitoring on Snake and Clearwater Rivers

Links to: project **and** reports

Proponent: Nez Perce Tribe

Province/subbasin: Mountain Snake/Clearwater, Upper Snake/Snake Upper

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat Estuary, Plume and Ocean: What specific factors affect survival and migration of species and life-history types of fish through the estuary, and how is the timing of ocean entry related to subsequent survival?
- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?

Comment:

The Nez Perce Tribe Harvest Monitoring project collects, analyzes, and reports catch data pursuant to pre-planned statistical sampling designs and procedures to assure the conduct of biologically sound harvest strategies for Nez Perce treaty fisheries that may affect ESA listed species. Sampling has been ongoing since 2005. The Nez Perce Tribe conducts its Treaty fisheries using traditional fishing gear and methods, many of which are non-selective. The Tribe submitted a proposal to investigate the use of live-capture fishing gear, but it was not selected for funding.

This project addresses the uncertainty associated with harvests by the Nez Perce Tribe, including take of ESA-listed salmonids. It indirectly addresses the critical uncertainty for harvest listed above.

Methods: In most areas, a post season survey is conducted in tributaries; in-season surveys are conducted in Zone 6.

Program relevance and brief summary of findings: In 2013, the project documented that the Nez Perce Tribe captured 8,315 salmon and steelhead in Zone 6 and in Snake River basin tributaries. Hatchery and wild salmon are identified. A goal of the Nez Perce Tribe is to manage Treaty harvests consistent with the conservation needs of the fish and rebuilding of naturally spawning populations. Accordingly, the Tribe applies take limits for directed harvest of listed fish that are monitored consistent with statistical sampling designs and survey methods that provide the "optimal sampling strategy" per fishery area to provide statistically valid quantitative estimates of Tribal harvest.

Broad Applicability: Limited to stocks harvested by the Nez Perce, including ESA-listed fish.

Time Required: Ongoing monitoring of tribal harvests is important. 2013 harvests were reported, but 2014 harvests are not yet reported.

200810500 - Selective Gear Deployment

Links to: project **and** reports

Proponent: Colville Confederated Tribes

Province/subbasin: Columbia Cascade/Okanogan

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Harvest: What new harvest and escapement strategies can be employed to improve harvest opportunities and ecological benefits within the Columbia Basin while minimizing negative effects on ESUs or populations of concern? Can genetic techniques be used to quantify impacts on wild or ESA-listed stocks in ocean fisheries?
- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?

Indirect or Potential:

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?

Comment:

This project specifically addresses two critical uncertainties: (1) reducing density dependence and introgression associated with hatchery fish spawning in streams, and (2) enabling harvests by tribal members while minimizing negative impacts of natural populations. After testing a variety of fishing gears, the project identified purse seine and beach seine as two gears that effectively captured salmon while allowing live release (>99% immediate survival). A weir was also identified as a means to harvest additional surplus hatchery fish. The project has broad applicability throughout the Basin, but post-release survival of wild Chinook salmon remains a critical uncertainty. A successful demonstration of this project may encourage other tribes to employ mark selective fisheries as a means to increase harvests while also reducing ecological and genetic impacts of surplus hatchery fish (i.e., those beyond the capacity) spawning with natural salmon.

Methods: The project used three gears to assess whether they were effective for live capture with the intent to sort and retain hatchery origin fish and release native origin fish. A variety of gears were tested to determine which gears readily captured targeted Chinook and sockeye while allowing live release of ESA-listed Chinook salmon. Post release survival was not monitored, but the investigators have examined some literature. A major portion of the most recent report concerns standard operating procedures for boating safety.

Program Relevance and Project Results: The proponents presented a brief summary of the catches by gear type and reported that the purse seine was most effective and caused the least immediate mortality. The report provides data summaries but not thorough analyses. An important remaining uncertainty is: how does capture and release in purse or beach seine gear affect the reproductive success of wild salmon in this region?

Broad Applicability: Very broad applicability. The ISAB report on density dependence showed that there is often a surplus of hatchery salmon that spawn in tributaries and that total spawners often exceed the capacity of the watershed to support a salmon population, i.e., return per spawner is less than 1. Mark selective fishing in terminal areas provide a potential win-win situation: fishermen catch fish while surplus hatchery fish are removed from spawning streams, thereby increasing the chance for ESA-listed stocks to develop locally adapted traits. The Colville Tribe hopes that selective capture of hatchery origin fish will mitigate the imminent opening of their hatchery and the adverse effects that hatchery fish may have on native fishes. This project is a test of the effectiveness of a mark-selective fishery in a terminal area.

Time Required: The project has identified the most effective gears: purse seine, beach seine, and a weir. A report has not been produced since 2011, so recent progress is unknown, including whether the project has addressed the ISRP's concerns and Council conditions during the 2010 review. Monitoring and evaluation of catch and release of wild Chinook salmon and associated mortality is warranted.

Predator Control

199702400	Avian Predation on Juvenile Salmonids	Oregon State University, Real Time Research
199007700	Development of Systemwide Predator Control	Pacific States Marine Fisheries Commission
200800400	Sea Lion Non-Lethal Hazing	Columbia River Inter-Tribal Fish Commission (CRITFC)

AFEP Avian Predation Studies[4]

AFEP 2014-13	Status of Caspian tern breeding colonies at both managed and unmanaged sites in the Columbia Basin and at Corps-constructed islands
AFEP 2014-14	Connectivity of managed and un-managed Caspian tern breeding colonies as revealed by resightings of banded individuals
AFEP 2014-15	Caspian tern response to management at Goose Island, Potholes Reservoir, as indicated using satellite telemetry
AFEP 2014-16	Caspian tern predation on juvenile salmonids in the Columbia River Basin: a synopsis of PIT tag recovery method, analyses, and results from 2014

Overview of the Four 2014 AFEP Studies

These four AFEP avian predation studies are closely integrated and complement project 1997-024-00 (Avian predation on juvenile salmon). The first three AFEP studies are designed to provide status and trends data on Caspian terns breeding at the most significant colonies in Washington and Oregon. These data include the number of breeding pairs at each site and their breeding success (young/breeding pair), year-to-year fidelity to the breeding sites ("connectivity" estimated by re-sighting of banded individuals), the proportion of breeding birds that are displaced by habitat modifications to the nesting sites, and the subsequent movements and foraging locations of displaced birds (based on tracking of satellite tags). The final AFEP study (2014-16) involves modeling to estimate how much the overall consumption of

[4] This table lists study presentations from the 2014 Annual Research Conference for the U.S. Army Corps of Engineers' Anadromous Fish Evaluation Program. This overview provides a snapshot of AFEP efforts and is *not* intended to be a comprehensive analysis of AFEP.

juvenile salmonids has been reduced by the habitat modifications that caused the birds to change their foraging locations during the period of smolt migration.

Collectively, these closely integrated projects directly address an important new uncertainty about habitat restoration - how deliberate changes to bird nesting sites on islands in the Columbia River estuary and inland reservoirs could reduce avian predation and improve the survival of salmon smolts during their downstream migration.

199702400 - Avian Predation on Juvenile Salmonids

Links to: project **and** reports

Proponent: Oregon State University, Real Time Research

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat Estuary, Plume and Ocean: What is the significance to fish survival, production, and life-history diversities of habitat degradation or restoration in the estuary as compared with impacts to other habitats in the basin? How does this partitioning of effects vary among species and life-history types?
- Habitat Estuary, Plume and Ocean: What specific factors affect survival and migration of species and life-history types of fish through the estuary, and how is the timing of ocean entry related to subsequent survival?
- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Monitoring and Evaluation (adaptive management): Can a scientifically credible trend monitoring procedure based on remote sensing, photography, and data layers in a GIS format be developed?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Habitat: How does habitat restoration in the estuary affect the survival and migration of salmon smolts through the estuary

Comment:

This project indirectly addresses two 2006 uncertainties. First, by evaluating the magnitude of bird predation in relation to the overall abundance of juvenile salmonids migrating in the mainstem Columbia River, it provides information relevant to investigating the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater and estuarine (but not ocean) habitats. However, as the ISRP (2010) has pointed out, what remains most uncertain is “the predator influence on the overall survival rate of the various stocks (is it mostly compensated for or is it additive)? ... Perhaps avian biologists working with salmon biologists can address this critical issue by working together on salmon life stage models for various stocks, especially since predation rates seem to vary among species and stocks.”

Second, the project indirectly addresses, or could potentially address, additional uncertainties related to the development of trend monitoring procedures based on remote sensing, photography, and data layers in a GIS format.

It also indirectly addresses a new uncertainty about how habitat restoration in the estuary (deliberate changes to bird nesting sites) affects the survival and migration of salmon smolts through the estuary.

Methods: Methods seem appropriate, and the project was reviewed favorably by the ISRP (2010). Bird abundance is estimated primarily from counts based on aerial photography and Monte Carlo simulations to determine confidence intervals.

Program Relevance and Project Results: This project monitors trends in the abundance and feeding rates of piscivorous birds (Caspian terns, double-crested cormorants and others) in the estuary, Columbia Plateau and at alternative sites in SE Oregon and N California where the Corps of Engineers has strategically modified and relocated nesting habitat for the birds in an effort to reduce their impact on salmon smolts.

In 2013, approximately 7400 breeding pairs of terns nested on East Sand Island, an increase of about 1000 pairs over 2012. This was the first increase since 2010 when managers began taking actions to discourage the birds and to reduce the breeding area, which has caused a density dependent reduction in tern breeding success. Some birds are now nesting on alternative sites created by the Corps rather than in the estuary.

During 2004-2013, double-crested cormorants nesting at East Sand Island consumed primarily sub-yearling Chinook salmon (ca. 7.8 million smolts/year), followed by coho salmon, steelhead, and yearling Chinook salmon (ca. 2.4, 1.1, and 1.0 million smolts/year, respectively). Recoveries of smolt PIT tags on the East Sand Island cormorant colony in 2013 indicated that population- or ESU-specific predation rates ranged from 0.7% to 2.9% for populations originating upstream of Bonneville Dam on the Columbia River or upstream of Sullivan Dam on the Willamette River. Despite the increase in the size of the cormorant colony in 2013, the ESU-specific predation rates measured in 2013 were some of the lowest recorded since 2007.

Estimates of Caspian tern predation rates on salmonids based on smolt PIT tag recoveries on tern colonies in the Columbia Plateau region indicated that impacts were greatest on the upper Columbia River steelhead population (14.9% depredated by terns from the Goose Island colony) and on the Snake River steelhead population (2.8% depredated by terns from the Crescent Island colony). Predation rates by Goose Island terns on upper Columbia River yearling Chinook were also notable (2.1%) but significantly lower than predation rates on steelhead. Predation rates by Caspian terns nesting at the small colony in the Blalock Islands were an order of magnitude less than those of terns nesting at Goose and Crescent islands, but steelhead were still highly susceptible to predation by terns from this colony.

New results suggest that smolt predation rates by gulls nesting at some colonies in the Columbia Plateau region are comparable to, if not higher than, those of Caspian terns and double-crested cormorants nesting at colonies in the Columbia Plateau region.

Currently there are no plans to manage colonies of cormorants, gulls, or white pelicans in the Columbia Plateau region based on previous research investigating their relative impacts on survival of juvenile salmonids.

Reporting: Reporting is generally excellent and includes several primary publications. The latest annual report available through PISCES describes detailed results for 2013 but also updates long-term time series and provides retrospective evaluations of the whole project.

Broad Applicability: Rates of bird predation are very site specific, but the study area is broad including the Columbia River from the mouth (river km 0) to the head of the impoundment created by McNary Dam (river km 553). The project also monitors a variety of piscivorous birds.

Time Required: Long term. The project has now developed a 14-year database on abundances, breeding success, and diets of terns and a 17-year database on cormorants in the estuary. Shorter data sets have been developed for birds in the Columbia Plateau and at the alternative sites. This monitoring appears warranted as long as concerns exist about the impact of bird predation on salmon populations.

199007700 - Development of Systemwide Predator Control

Links to: project **and** reports

Proponent: Pacific States Marine Fisheries Commission

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: What are the impacts of hydrosystem operations on mainstem habitats, including the freshwater tidal realm from Bonneville Dam to the salt wedge? How might hydrosystem operations be altered to recover mainstem habitats?
- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?
- Non-native and invasive species: What is the current distribution and abundance of invasive and deliberately introduced nonnative species (e.g., the baseline condition), and how is this distribution related to existing habitat conditions (e.g., flow and temperature regimes, human development, restoration actions)?

Comment:

This project directly addresses uncertainties about fish predation on juvenile salmonids migrating in the mainstem Columbia and Snake Rivers and is designed to evaluate and improve the effectiveness of programs to control fish predators.

The project indirectly addresses, or could potentially address, four of the 2006 uncertainties. It provides data related to the impacts of the hydrosystem on mainstem habitat (i.e., its suitability for fishes that eat salmon smolts), the distribution of non-native fish species (primarily smallmouth bass and walleye) and their potential to affect the recovery of native salmonid species. It also provides data that could be used for the development of models for predicting the abundance or presence-absence of focal species.

Methods: The methods appear appropriate. They include mark-recapture studies to estimate pikeminnow abundance, stomach contents analysis to estimate consumption rate, and modeling to estimate rates of removal of pikeminnow, the effect of that removal rate on salmonid survival, and the potential for compensatory responses by other predators in the lower Snake River reservoirs. Note that the ISRP (2010) recommended investing in an updated review of the methods (before the next review cycle) by scientists with expertise in current capture-recapture methods, to ensure that the best methods are being used.

Program Relevance and Project Results: This project involves three agencies (PSMFC, ODFW, WDFW) and is primarily focused on status and trends monitoring, although some activities include research. The project's primary objectives are to: 1) implement a sport-reward fishery systemwide (*i.e*., below Priest Rapids Dam in the Columbia River and below Hells Canyon Dam in the Snake River) and operate a system for collecting and disposing of harvested northern pikeminnow and 2) estimate reductions in predation on juvenile salmonids resulting from pikeminnow harvest and update information on year-class strength of pikeminnow. Additional objectives are to characterize population dynamics of pikeminnow, smallmouth bass *Micropterus dolomieu* and walleye *Sander vitreus* in the lower Snake River reservoirs; and assess evidence of possible intra- and inter-specific compensatory responses by these predators related to the sustained removal of pikeminnow.

Since inception of the removal program in 1991, the annual removal of large pikeminnow (> 228mm) has ranged between 110,000 and 270,000, and the exploitation rate has been estimated at 10 - 20% per year. These removals are estimated to have reduced predation on juvenile salmonids by ~35% in 2013. The diets of smallmouth bass and walleye do not include a large proportion of salmonids (~8 - 18%), but these non-native predators have become more numerous in some areas of the lower Snake River; abundance indices there were higher in 2013 than in any other year since the project began (1991). This increased abundance may be an early indication of a localized compensatory response to pikeminnow removal.

This fish predator removal program is clearly relevant to the management of salmon, and continued monitoring of removals is important for verifying the effectiveness of the program. However, the ISRP (2010) concluded that "the overall significance of the northern pikeminnow removals on SARs remains unknown, relative to marine survival, in particular."

Reporting: Annual reports are up-to-date (last year covers 2014), detailed, and well organized. They also provide updated time series and evaluations that span the entire 25 years of the program.

Broad Applicability: Rates of fish predation are site specific, but the study area is broad including the entire Columbia River below Priest Rapids Dam and Snake River below Hells Canyon Dam.

Diet analyses of smallmouth bass and walleye in the Snake River and the determination of a compensatory response by these species to the removal of pikeminnow could be applied or adapted for use in other parts of the Columbia Basin where predator controls might be planned.

Time Required: This long-term project has already been conducted annually for 25 years. The project might be warranted as long as there is concern about fish predation on juvenile salmon.

200800400 - Sea Lion Non-Lethal Hazing

Links to: project **and** reports

Proponent: Columbia River Inter-Tribal Fish Commission (CRITFC)

Province/subbasin: Lower Columbia/Columbia Lower

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat Estuary, Plume and Ocean: What specific factors affect survival and migration of species and life-history types of fish through the estuary, and how is the timing of ocean entry related to subsequent survival?
- Habitat: What are the impacts of hydrosystem operations on mainstem habitats, including the freshwater tidal realm from Bonneville Dam to the salt wedge? How might hydrosystem operations be altered to recover mainstem habitats?
- Mainstem Hydrosystem Flow and Passage Operations: What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species and stocks? What are the ecological effects of hydrosystem operations on downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?

- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

Comment:

This project indirectly addresses three of the 2006 uncertainties. First, it could help to evaluate the impact of hydrosystem operations on mainstem habitats in the freshwater tidal realm below Bonneville Dam (by providing data on sea lion abundance and use of estuarine habitat). Second, it could help to evaluate the ecological effects of hydrosystem operations on specific factors affecting the survival and migration of salmon smolts and other species in the Columbia River estuary (by providing data on the abundance and predation rate of sea lions in the estuary, and near the Bonneville Dam where adult salmon and sturgeon are particularly vulnerable). Third, the project could potentially address the 2006 uncertainty related to the development of empirical models to predict abundance of focal species concurrent with the collection of data on status and trends.

Methods: Methods seem appropriate. Statistical procedures are used to estimate sea lion abundance in each of 4 zones between Bonneville Dam and Astoria based on visual counts from tandem boat surveys. Most of the survey activity is concentrated in the two zones below Bonneville to the Cowlitz River. Participants also haze the sea lions and collect data on sea lion responses to hazing and incidents of predation.

Program Relevance and Project Results: The project's objectives primarily relate to status and trends monitoring: 1) estimate sea lion abundance in the lower Columbia beyond the view of observers stationed at Bonneville Dam, 2) determine abundance and distribution of sea lions confined in Bonneville Pool to aid in trapping and removal efforts, 3) investigate historical sea lion presence in the lower Columbia River, and 4) conduct boat-based non-lethal sea lion hazing annually generally between 1 March and 31 May in the Bonneville Dam tailrace.

Peak abundance of sea lions in the two zones below Bonneville each year has been estimated between 100-200 animals. However, the project does not include a protocol for estimating the number of salmonids and sturgeon consumed. The U.S. Army Corps of Engineers conducts observational monitoring of sea lion predation in the immediate trailrace area of Bonneville Dam.

It is not clear whether this project is integrated or could be integrated with the NOAA adult tagging study to estimate the survival of adult Chinook migrating upstream through the estuary; the ISRP and ISAB recommend integration, if feasible. In spring 2016, NOAA plans to continue its pinniped predation study in the lower river. In addition to the PIT-tag survival study, they plan to implant a portion of study fish with radio tags to follow their fine scale movement and survival below Bonneville Dam. In addition, they plan to work with state marine mammal biologists to equip sea lions with radio tags (personal communication, Michelle Rub, NOAA). State marine mammal biologists from ODFW and WDFW also conduct their own monitoring (and trapping) of sea lion and seal presence in the estuary and lower river.

Reporting: Annual reports are up to date, well organized and provide considerable detail. However, they focus on activities and results for the year in question and do not provide figures on trends over years or a retrospective synthesis of results from the entire project.

Broad Applicability: Results apply only to the study area near Bonneville Dam and downstream to Astoria. The project has little applicability beyond that study area.

Time Required: Long term. The project began the status and trends monitoring in 2008 and its continuation is warranted as long as concerns remain about the impacts of sea lion predation.

Lamprey

200852400	Implement Tribal Pacific Lamprey Restoration Plan	Columbia River Inter-Tribal Fish Commission (CRITFC)
199402600	Pacific Lamprey Research and Restoration Project	National Oceanic and Atmospheric Administration, Umatilla Confederated Tribes (CTUIR)
200830800	Willamette Falls Lamprey Escapement Estimate	Confederated Tribes of Warm Springs
200847000	Yakama Nation Ceded Lands Lamprey Evaluation and Restoration	Yakama Confederated Tribes
201101400	Evaluate Status & Limiting Factors of Pacific Lamprey in the lower Deschutes River, Fifteenmile Creek and Hood River Subbasins	Confederated Tribes of Warm Springs

AFEP Lamprey Studies[5]

AFEP 2014-28	The 2014 adult Pacific lamprey migration: HD-PIT and radiotelemetry summaries
AFEP 2014-29	Using the Juvenile Salmon Acoustic Telemetry (JSATS) system to evaluate adult Pacific lamprey movements and fate in Columbia River reservoirs, 2011-2014
AFEP 2014-30	Pacific Lamprey swimming behavior and performance in relation to passage barrier velocity, distance and turbulence in an experimental flume, 2014
AFEP 2014-31	Development and use of lamprey passage structures at the Bonneville Dam Lamprey Flume System and John Day Dam North Fishway Entrance, 2013-2014
AFEP 2014-32	Modification and evaluation of lamprey passage structures (LPSs) at Bonneville Dam and the John Day south fishway collection trap, 2014
AFEP 2014-33	If you build it they will come: an experimental vertical climbing wall
AFEP 2014-34	Use of Network Theory to Evaluate Fish Passage Behavior at Bonneville Dam
AFEP 2014-35	Evaluation of Adult Lamprey Passage Behavior in Relation to Prototype McNary Dam South Shore Entrance Structure and Estimating Total Ladder Escapement Through McNary and Ice Harbor Dams
AFEP 2014-36	Evaluation of Adult Pacific Lamprey Migration Behavior and Passage Success in Lower Snake River
AFEP 2014-37	Assessment of Fluctuating Reservoir Elevations Using Hydraulic Models and Impacts on Larval Pacific Lamprey Rearing Habitat in the Bonneville Pool
AFEP 2014-38	Evaluation of Larval Pacific Lamprey Rearing in Mainstem Areas of the Columbia and Snake Rivers Impacted by Dams

[5] This table lists study presentations from the 2014 Annual Research Conference for the U.S. Army Corps of Engineers' Anadromous Fish Evaluation Program. This overview provides a snapshot of AFEP efforts and is *not* intended to be a comprehensive analysis of AFEP.

Summary

The recovery of Pacific lamprey in the Columbia River Basin faces many of the same issues seen for Pacific salmon. These primarily center on the loss of adequate habitat and the need for adults and juveniles to migrate through the hydropower system. Thus, many of the critical uncertainties identified for salmon are similar for lamprey. The unique biology and life history of lamprey, however, may require different approaches to addressing these uncertainties. How some of the uncertainties stated in the 2006 NPPC Research Plan relate to Pacific lamprey Bonneville Power Administration (BPA) and US Army Corps of Engineers (COE) projects is demonstrated in the following:

- Contaminants: How do toxic substances, alone and in combination, affect fish and wildlife distribution and abundance, survival, and productivity? [6]
- Contaminants: What is the distribution and concentration of toxics, including emerging contaminants, in the Columbia River Basin, and what are/have been their trends over time?

Because lamprey may spend as much as 10 years in fine sediments, persistent organic contaminants -- which include pesticides, flame retardants, pharmaceuticals, and legacy contaminants such as PCBs -- may have a greater impact on them than on juvenile salmonids. Several projects (*Yakama Nation Ceded Lands Lamprey Evaluation and Restoration 200847000, Implement Tribal Pacific Lamprey Restoration Plan 200852400*) are looking at the presence of contaminants in lamprey and the sediments in which they are found.

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Habitat: What are the impacts of hydrosystem operations on mainstem habitats, including the freshwater tidal realm from Bonneville Dam to the salt wedge? How might hydrosystem operations be altered to recover mainstem habitats?

Several BPA-funded projects are involved in lamprey habitat restoration and assessment of limiting factors in lamprey habitat (*Pacific Lamprey Research and Restoration Project 199402600, Yakama Nation Ceded Lands Lamprey Evaluation and Restoration 200847000, Implement Tribal Pacific Lamprey Restoration Plan 200852400, Evaluate Status & Limiting Factors of Pacific Lamprey in the lower Deschutes River, Fifteenmile Creek and Hood River Subbasins 201101400)*. Larval Pacific lamprey settle in fine silty sediments, so they are able to rear in mainstem areas that are not appropriate for salmon. A number of U.S. Army Corps of Engineers (COE) projects are exploring lamprey habitat use in the

[6] For example, see Reconnaissance of contaminants in larval Pacific lamprey (Entosphenus tridentatus) tissues and habitats in the Columbia River Basin, Oregon and Washington, USA. Elena B. Nilsen, Whitney B. Hapke, Brian McIlraith, Dennis Markovchick.

mainstem Columbia and Snake Rivers (*Assessment of Fluctuating Reservoir Elevations Using Hydraulic Models and Impacts on Larval Pacific Lamprey Rearing Habitat in the Bonneville Pool; Evaluation of Larval Pacific Lamprey Rearing in Mainstem Areas of the Columbia and Snake Rivers Impacted by Dams.)*

- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Potential Additional Uncertainty (not in 2006 Research Plan)

- Fish Propagation: What are the best practices (e.g., translocation, fish culture) and associated methodologies for reestablishing Pacific lamprey populations in the Columbia Basin?

Efforts are underway to reintroduce lamprey into tributaries initially by translocation of adults collected at Bonneville Dam, but artificial production is also being explored *(Pacific Lamprey Research and Restoration Project 199402600)*. Initial translocation efforts resulted in an almost two orders of magnitude increase in larval density from 0.08 larvae/m^2 to 6.56 larvae/m^2 after adult Pacific lamprey were reintroduced into the Umatilla River. Pacific lamprey have also been translocated into the Snake River Basin *(Implement Tribal Pacific Lamprey Restoration Plan 200852400).*

- Harvest: What new harvest and escapement strategies can be employed to improve harvest opportunities and ecological benefits within the Columbia Basin while minimizing negative effects on ESUs or populations of concern? Can genetic techniques be used to quantify impacts on wild or ESA-listed stocks in ocean fisheries?

By exploring the fate of Pacific lamprey in the Willamette River, tribal biologists hope to increase harvest at Willamette Falls, which is one of the most productive areas in the Columbia River Basin for Native American “eelers” *(Willamette Falls Lamprey Escapement Estimate 200830800).*

- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?

As with salmonids, Pacific lamprey migrate to the ocean and, after some time, return to fresh water to spawn. Pacific lamprey migrations as juveniles and adults are impacted by passage through the hydropower system. While uncertainties that mention “smolts” would not seem to relate to lampreys, as juveniles they experience a metamorphosis similar to salmon in preparation for emigration. Adults must also pass dams and significant efforts are being expended to improve the rate and success of their passage. BPA-funded projects are examining lamprey migration and passage in the mainstem *(Yakama Nation Ceded Lands Lamprey Evaluation and Restoration 200847000, Implement Tribal Pacific Lamprey Restoration Plan 200852400).* Nine COE-funded projects are also addressing these issues (e.g., *The 2014 adult Pacific lamprey migration: HD-PIT and radiotelemetry summaries; Using the Juvenile Salmon Acoustic Telemetry (JSATS) system to evaluate adult Pacific lamprey movements and fate in Columbia River reservoirs, 2011-2014; Development and use of lamprey passage structures at the Bonneville Dam Lamprey Flume System and John Day Dam North Fishway Entrance, 2013-2014).*

- Plume and Ocean: What are the effects of commercial and sport fishing on ocean food webs?

While there are no BPA or COE projects looking at lamprey in the ocean, one project *(Implement Tribal Pacific Lamprey Restoration Plan 200852400*) is planning a workshop focused on the marine phase of the Pacific lamprey life history. Other researchers in the region have found a strong correlation between commercial landings of several marine species (including Chinook salmon) and the counts of immigrating adult Pacific lamprey at Bonneville Dam (Murauskas, J.G., A.M. Orlov, and K.A. Siwicke. 2013. Transactions of the American Fisheries Society 142:1, 143-155). These marine fish are an important source of food and transportation for lamprey in the ocean. The decrease in commercial landings since the mid-twentieth century mirrors the decrease in Pacific lamprey in the Columbia River Basin.

The five Pacific lamprey below projects should be viewed as a group. The projects are Pacific Lamprey Research and Restoration Project (199402600), Willamette Falls Lamprey Escapement Estimate (200830800), Yakama Nation Ceded Lands Lamprey Evaluation and Restoration (200847000), Implement Tribal Pacific Lamprey Restoration Plan (200852400), Evaluate Status & Limiting Factors of Pacific Lamprey in the lower Deschutes River, Fifteenmile Creek, and Hood River subbasins (201101400). This project is particularly similar to "Pac. Lamprey Research & Restoration Project" number 199402600.

200852400 - Implement Tribal Pacific Lamprey Restoration Plan

Links to: project **and** reports

Proponent: Columbia River Inter-Tribal Fish Commission (CRITFC)

Province/subbasin: Lower Columbia/Willamette

2006 Research Plan uncertainties addressed:

Direct:

- Contaminants: What is the distribution and concentration of toxics, including emerging contaminants, in the Columbia River Basin, and what are/have been their trends over time?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Indirect or Potential:

- Contaminants: How do toxic substances, alone and in combination, affect fish and wildlife distribution and abundance, survival, and productivity?
- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?
- Population Structure and Diversity: What approaches to population recovery and habitat restoration are most effective in regaining meta-population structure and diversity that will increase viability of fish and wildlife in the Columbia River Basin?

Comment:

This project has numerous collaborators (CRITFC, Nez Perce, Oregon State University, two USGS labs, University of British Columbia), each doing research to directly address numerous critical uncertainties. As the project name implies, it is to implement many elements of a basinwide lamprey restoration plan.

Methods: The methods appear sound, and, in fact, several publications have come from work presented in the Dec 2014 annual report.

Program Relevance and Project Results: The results of this group of research projects will be highly relevant to the continued restoration of lamprey in the Columbia Basin. Results include the: (1) development and validation of genetic markers composed of 96 single nucleotide polymorphisms (SNPs) used to identify genetic structure of populations, parentage of juveniles and ultimately the reproductive success of translocated adults and hatchery juveniles; (2) documenting the presence of contaminants in adult and larval lamprey and the sediments from which they were collected; (3) validating a methodology for accurately counting lamprey redds in tributaries; and (4) the distribution of juvenile lamprey in the Willamette and Snake River Basins. An approach that can be used to estimate larval lamprey mortality during their 3 to 8 year tenure in freshwater was also described. Additionally an overall estimate of mortality during the larval stage for Pacific Lamprey in the Willamette River was presented. It appears that the figures and tables associated with the comprehensive contaminants study performed by USGS/CRITFC which is included in this report can be found on pages 387-406 in the August 2014 "Yakima Nation Pacific Lamprey Report (Project No. 2008-470-00).

Broad Applicability: The results of these research projects will have broad applicability throughout the Columbia Basin at levels from stream-reach to landscape and tributary to mainstem.

Time Required: The project has been in place for 7 years and, as it is to implement an extensive restoration plan, will reasonably continue for many years--perhaps decades--as individual elements are completed and new ones are initiated.

199402600 - Pacific Lamprey Research and Restoration Project

Links to: project **and** reports

Proponent: National Oceanic and Atmospheric Administration, Umatilla Confederated Tribes (CTUIR)

Province/subbasin: Columbia Plateau/Umatilla

2006 Research Plan uncertainties addressed:

Indirect or Potential

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Fish Propagation: What are the best practices (e.g., translocation, fish culture) and associated methodologies for reestablishing Pacific lamprey populations in the Columbia Basin?

Comment:

This project directly addresses uncertainties of habitat restoration's effects on survival, distribution, and migration of Pacific lamprey and the success of restoration actions that might address long-term viability of Pacific lamprey populations. A before- and after- sampling design might help make a more direct assessment of the uncertainty.

This project is composed of four lamprey research questions conducted by different research groups. The Umatilla Tribe is examining the translocation of adult lamprey collected at mainstem dams into the Umatilla River where lamprey have been extirpated. NOAA Fisheries is looking at lamprey passage at low-head barriers and lamprey passage systems, and also the initial steps in developing lamprey propagation. USGS is looking at the effectiveness of various types of irrigation screens on juvenile lamprey. This last group provided only a listing of issues and activities, but no methods or results. The report was issued in Dec 2014 and covers work going back to 2006.

Methods: Methods appear appropriate, but data were not tested statistically as there are very small sample sizes. Most results were listed as number of fish (adults, larvae, and metamorphosing juveniles) passing or collected at a barrier. Year-to-year changes were not compared. Exceptions were the propagation studies where survival and growth were presented and some comparisons were made. Also, a logistic regression was used to assign probabilities to adult lamprey passage over individual irrigation diversions in the Umatilla. It is surprising that logistic regressions were not used to estimate passage probabilities before and after changes were made to the diversion structures to expose the benefits the changes made.

Program Relevance and Project Results: This group of research projects is providing data relevant to management questions primarily by addressing habitat changes needed to allow lamprey migration in the tributaries and taking the first steps toward supplementation by translocation and propagation. At this time, the project is not addressing any of the uncertainties relative to hatchery-wild interactions, but it may lay the foundation needed to explore those in the future. Data on adult lamprey passage at Three Mile Dam could be used to establish a status and trend data set for Pacific lamprey in the Umatilla. The high level indicator touched on by the project would be abundance.

Broad Applicability: The results of these projects will have broad applicability to other watersheds where lamprey have been extirpated, where lamprey propagation is anticipated, or where irrigation screening is needed.

Time Required: This project has been going for about 20 years and has made contributions to our understanding of several aspects of lamprey biology other than what is presented in the most recent report (Dec 2014). The current studies may require more than 5 years to complete. For example, the number of adults returning to the Umatilla River is highly variable and will require additional time to determine the limiting factors, which may be outside of the watershed (e.g., mainstem passage or ocean survival).

200830800 - Willamette Falls Lamprey Escapement Estimate

Links to: project and reports

Proponent: Confederated Tribes of Warm Springs

Province/subbasin: Lower Columbia/Willamette

2006 Research Plan uncertainties addressed:

Direct:

- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

Indirect or Potential:

- Harvest: What new harvest and escapement strategies can be employed to improve harvest opportunities and ecological benefits within the Columbia Basin while minimizing negative effects on ESUs or populations of concern? Can genetic techniques be used to quantify impacts on wild or ESA-listed stocks in ocean fisheries?

Comment:

The primary uncertainty addressed directly by this project is to increase Pacific lamprey harvest opportunities. Other uncertainties may be addressed more indirectly as the project examines how limiting factors in the habitat (i.e., flow and routes of flow) affect lamprey passage at Willamette Falls and is developing a model to estimate abundance of lamprey at Willamette Falls.

Methods: It appears that the methods used (mark-recapture using PIT tags; creel survey; radio telemetry; correlation analysis) are sound. Their estimates of abundance have reasonable coefficients of variation (~10%).

Program Relevance and Project Results: The project has some research elements. The effect of water flows and the routes taken by water as it passes over the falls on lamprey passage is being evaluated. The behavior of lamprey tagged at the falls is being tracked and correlations between lamprey abundance at Willamette Falls with counts at Bonneville Dam are being made. However, the main objectives of the project are to monitor lamprey abundance and passage and Tribal harvest at Willamette Falls. It is reported that abundance has increased during the five years of the study and that there is a strong correlation (R^2=0.97) between that abundance and counts at Bonneville. Thus, in the near future the project may drop determining abundance empirically in favor of using the Bonneville Dam count correlation. They also report that as many as 67% of lamprey collected at the Falls, tagged and released 1.6 km downstream do not return to the Falls. They are exploring the fate of these non-returning fish.

Broad Applicability: This project has little applicability beyond the lower Willamette River. However, the use of "marker tags" to determine if a PIT tag detection array is functioning might be a very useful tool that could be used in other parts of the Basin if that is not already happening.

Time Required: Tribal fisheries for lamprey will continue, and there will be a need to estimate and regulate harvest rates so this part of the project will need to be continued into the foreseeable future. Also it will likely take several field seasons to determine the fate of tagged lamprey collected at the Falls and then released 1.6 km downstream that do not return to the Falls. Are they entering and spawning in Willamette tributaries below the falls or emigrating back to the Columbia and continuing to migrate upstream, or? And are these fish representative of lamprey that fail to navigate over the falls?

200847000 - Yakama Nation Ceded Lands Lamprey Evaluation and Restoration

Links to: project **and** reports

Proponent: Yakama Confederated Tribes

Province/subbasin: Columbia Gorge/Klickitat, Columbia Plateau/Yakima

2006 Research Plan uncertainties addressed:

Direct:

- Contaminants: What is the distribution and concentration of toxics, including emerging contaminants, in the Columbia River Basin, and what are/have been their trends over time?

Indirect or Potential:

- Contaminants: How do toxic substances, alone and in combination, affect fish and wildlife distribution and abundance, survival, and productivity?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- Fish Propagation: What are the best practices (e.g., translocation, fish culture) and associated methodologies for reestablishing Pacific lamprey populations in the Columbia Basin?

- What is the occurrence of Pacific Lamprey in the Yakima, Methow, Klickitat and White Salmon subbasins?
- What is the impact on adult lamprey when they must pass over multiple diversion dams to reach putative spawning areas?
- Does the type of screening present on a diversion dam influence larval entrainment?
- When do larval lamprey enter irrigation canals? Does it occur at the time an irrigation gate is raised in the spring or do they steadily enter throughout the irrigation season?
- What behavioral mechanisms are used by larval lamprey to pass through or over irrigation screens?
- What is the fate of lamprey juveniles that enter a diversion canal?
- How can fine sediment be controlled in diversion canals so that larval lamprey will not find them attractive rearing areas?
- Are accumulations of mercury and other contaminants in river sediments affecting lamprey recruitment?
- Does chronic exposure to mercury and other contaminants over four to six years of freshwater residency impair physiological functions, growth and survival of larval lamprey?
- Do increased levels of mercury in ammocoetes persist to the adult stage making them a significant human health risk?
- Can larval lamprey be marked or tagged making it possible to recognize them months after marking or tagging?

Comment:

This project contains numerous individual research studies all of which address critical uncertainties relative to the restoration of Pacific lamprey in the Yakima watershed specifically and the whole basin generally.

Reports on 15 separate lamprey studies and two planning efforts were presented. Contributors to the report were the Yakama Nation Fisheries Resource Management Program, USFWS, Portland State University, PNNL, USGS, CRITFC, Fishhead Technology, and HRD Engineers. Six of the lamprey studies looked for presence/absence of larval Pacific and Western Brook lamprey in the Yakima, Methow, Klickitat, White Salmon, and Wind rivers and Fifteenmile Creek subbasins. Four other studies dealt with the impacts of irrigation diversion dams on adult and juvenile lamprey in the Yakima subbasin. One of these performed by the USFWS**,** used radio telemetry to assess passage efficiencies across the Sunnyside and Wapato diversion dams. The other three examined different aspects of entrainment of larval lamprey into diversion canals. Another report covered the results of developing and testing a larval lamprey trap that could be used immediately above and below irrigation screens. These same researchers also performed a controlled experiment that examined whether artificially cultured larval lamprey were differentially attracted to sediments with different types of amendments (e.g. salmon flesh, yeast, straw, etc.). They also performed a bioassay that examined the formalin concentrations that could be safely used on lamprey juveniles.

Another separate laboratory study performed by YNFRMP personnel evaluated the visibility and longevity of Visible Implant Elastomer (VIE) tags on larval lamprey. This group also created a pictorial field guide that can be used to identify larval Western Brook lamprey and Pacific Lamprey based on differences in tail fin pigmentation. Two projects examined contaminants. One performed by PNNL examined the occurrence of methylated mercury in larval lamprey and sediments collected in the Wind and Klickitat Rivers and Fifteenmile Creek. Tissues from adult lamprey obtained at Bonneville were also assayed for the presence of mercury. Results of the other contaminant study, performed by USGS and CRITFC had no accompanying text. Instead results of a suite of contaminant assays were presented in tables and figures. Suggested designs for Lamprey Passage Structures at the Prosser and Sunnyside Diversion Dams were presented in a planning report. And a draft of another planning document "A Comprehensive Framework for Pacific Lamprey Supplementation" was included in the report. This framework identified numerous uncertainties associated with lamprey supplementation and provides guidance on how they should be addressed.

Methods: The studies that examined the presence/absence of lamprey in subbasins used appropriate methods to determine *a priori* habitat areas that would be suitable for larval lamprey. Standardized electroshocking methods were employed to capture larval lamprey and a computer software program was used to map the areas sampled. Suitable radio telemetry and statistical methods were employed to assess adult passage success at Sunnyside and Wapato Diversion Dams. Larval collection and site mapping methods used in the three studies that examined entrainment of larval lamprey at diversion sites were appropriate. Results from these studies were mainly reported as observations, statistical analyses were rarely employed. Similarly, observational results were used to describe the results of the laboratory/field assessments made on the effectiveness of a larval lamprey trap, larval attraction to sediments with various amendments, and juvenile lamprey tolerance to various formalin treatments. This was surprising since care was taken to make these experiments very amenable to statistical analyses. The study that evaluated tag retention and visibility also used observational reports. The contaminants studies were rigorously performed. Suitable laboratory detection procedures were used. In the case of the mercury contaminant study, statistical analyses were performed and p-values were presented.

Program Relevance and Project Results: Numerous uncertainties associated with lamprey management were addressed by the studies presented in this report. Some of them are listed above under "additional uncertainties…" The project's investigations have produced a number of important findings. Pacific Lamprey were rare in the subbasins that were surveyed. Seasonal effects at Yakima diversion dams have the potential to exacerbate cumulative adult passage. Passage efficiencies, for example, at lower diversion dams were low in the fall when passage efficiencies at upper sites were at their highest. Surveys at diversion sites found numerous larval lamprey living in sediments above and below irrigation screens. The numbers living at these sites were positively correlated with the occurrence and volume of fine sediment. Fewer lamprey were found below screens with small mesh sizes than those with relatively larger mesh sizes. It was noticed that artificial structures like "Ecology Blocks" were creating areas with fine sediment, and it was suggested that such structures could be used to create suitable habitats for larval lamprey adjacent to diversion structures. Larval lamprey were successfully tagged using VIEs and these marks were retained for at least 154 days.

A wide variation in methylated mercury was found in larvae and in the sediments they lived in. Fish sampled in the Klickitat River had methylated mercury levels that were three times higher than those found in the Wind River and Fifteen-Mile Creek. The levels detected most likely caused some adverse effects to occur to the larvae. Additionally, these high levels were retained in adults making some of them a health risk to humans.

The presence/absence surveys for Pacific and Western Brook Lamprey established reference sites for future abundance estimates. Results from repeated sampling at these sites overtime will provide status and trend information for both of these species.

Broad Applicability: Many of the studies presented in this report will have broad application throughout the parts of the Basin that have lamprey present.

Time Required: In general, results have been reported in a timely fashion. Many uncertainties still remain and more work clearly needs to be done. This work will likely take more than five years to complete.

201101400 - Evaluate Status & Limiting Factors of Pacific Lamprey in the lower Deschutes River, Fifteenmile Creek and Hood River Subbasins

Links to: project **and** reports

Proponent: Confederated Tribes of Warm Springs

Province/subbasin: Columbia Gorge/Fifteenmile, Columbia Gorge/Hood, Columbia Plateau/Deschutes

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

Comment:

This project is directly addressing critical uncertainties associated with Pacific lamprey and their habitat in several Oregon watersheds in the mid-Columbia River.

Methods: Pacific lamprey abundance in the Deschutes and Hood rivers and Fifteenmile and Mill creeks was estimated by using a single census mark-recapture procedure (modified Petersen type). Assumptions associated with the method were tested, and 95% Confidence Intervals were provided for each point estimate made. Passive integrated transponder (PIT) tag arrays placed throughout these drainages were used to track the distribution of adults and to help identify possible migration barriers (e.g. diversions or other obstructions). Additionally, a randomized reach selection procedure, standardized electroshocking methods, and habitat descriptions were employed to estimate the presence/absence, distribution and abundance of lamprey ammocoetes in the subbasins. Additionally, the beginnings of a pre- and post-restoration look at larval density and potential re-colonization of the Hood River following the decommissioning of Powerdale Dam in 2010 was started. Harvest at traditional fishing sites was also estimated using creel surveys.

Program Relevance and Project Results: The project has estimated that lamprey abundance at Sherars Falls has increased from 2,000 fish in 2010 to ~11,500 in 2013. They have also established baseline data on the density of juvenile lamprey in several creeks. These data will help track quantitative biological objectives if those are established for lamprey in this area. Results from this work are being used to assess the status and trends of Pacific Lamprey returning to the Deschutes and Hood Rivers and Mill and Fifteenmile Creeks. Additionally an assessment of ammocoete abundance was used to help evaluate the effect of a habitat restoration project in Shitike Creek (Deschutes subbasin) on Pacific Lamprey. The project is also supplying harvest data to fisheries managers.

Broad Applicability: While this project is monitoring specific tributaries, the methods they have established for estimating abundance of adults and densities of juveniles will have applicability in other watersheds in the basin.

Time Required: The project has been in place in some form or another since 2002. It would appear that it will continue for many years as they monitor the recovery of the species in these tributaries.

Sturgeon

198605000	Evaluate Sturgeon Populations in the Lower Columbia River	Oregon Department of Fish and Wildlife
200850400	Sturgeon Genetics	Columbia River Inter-Tribal Fish Commission (CRITFC)
199502700	Lake Roosevelt Sturgeon Recovery	Spokane Tribe
200811600	White Sturgeon Enhancement	Colville Confederated Tribes
198806400	Kootenai River White Sturgeon Aquaculture Conservation Facility	Kootenai Tribe
200200200	Restore Natural Recruitment of Kootenai River White Sturgeon	Kootenai Tribe

Summary

There are common questions and uncertainties regarding sturgeon that cross sturgeon projects in many geographical areas. Overall, the sturgeon projects address some of these uncertainties indirectly. The Kootenai Step 2 document addressed two hatchery uncertainties, i.e., the issue of carrying capacity for stocked fish and genetic aspects of the stocking program. Overall, studies are not specifically focused on addressing the major uncertainties with a hypothesis-driven approach.

Major uncertainties include the following:

1. Recruitment and the factors affecting it remains *the* critical uncertainty for sturgeon in the basin and globally. Recruitment is monitored, but annual reports for Project 198605000 do not reflect the urgency of understanding the factors that influence variations in recruitment. More understanding of early life stages is needed, including predation on age-0 fish, specifically as it relates to recruitment. Recruitment must also be considered as it relates to the loss in connectivity of the river as a result of dams. It is vital to understand why reproduction and eventual recruitment are occurring, at least at some level, below Bonneville Dam and why recruitment deteriorates as one moves upriver. Of the factors that might affect recruitment (e.g. flows, turbidity, etc.) turbidity may be the most underappreciated. The river below Bonneville Dam, for example, does not have as much slack and standing water as areas above this dam. Consequently, the general turbidity of the river found below Bonneville might make young fish less susceptible to sight-feeding predation. It is important that effort be expended to identify what specific aspects of habitat that are affecting recruitment may be amenable to operational

changes and which might not. It would be helpful if proponents tested hypotheses about recruitment, so that scientific information on how dam operations affect recruitment in the reservoirs above Bonneville Dam could be obtained.

2. A conceptual framework is needed (e.g., life stages by age, sex and maturation) for understanding demographic data and its relevance. Biological data on white sturgeon are not broken out by age, sex, or life stage. There seems to have been limited effort to use data for effective harvest management beyond basic trend data usage. The absence of age determination data makes it difficult to interpret results of length, weight, and maturation data.

3. There does not seem to be an integrated approach to matching the harvest strategies of a fishery with data needs for management, resulting in creel assumptions and expansions that make it a challenge to make strong inferences about stock status. Sport fish sampling has presented particular challenges. A more structured (i.e., more spatially and temporally limited, more focused, and more heavily sampled) fishery, with intensive creel sampling of all aspects of biology and physiology could yield benefits.

4. More information is needed on periodicity and extent of movements to and from the estuary/nearshore ocean and its importance to population viability. The role of the estuary and ocean in maintaining the sturgeon stock below Bonneville Dam needs to be well understood. As noted by the proponents, micro-chemical techniques applied to sectioned fin rays of white sturgeon from the Lower Columbia River can be used to reconstruct the movements of individual fish (over the lifetime of the fish) to and from the river. Additionally, the use of acoustic telemetry to examine fine scale spatial movement and seasonal habitat use of white sturgeon in the lower Columbia River, the Columbia River Estuary, and near-shore marine habitats including coastal estuaries both north and south of the Columbia River would also provide important management information.

5. What are the specific factors that either allow or prevent sturgeon passage at mainstem dams, and how can sturgeon passage be improved? More effort should be directed on discovering what allows some sturgeon passage at The Dalles Dam but very little passage at other dams. This topic has been discussed before, but research on the issue remains to be done.

6. What is the expected carrying capacity of the various reservoirs in the Columbia River Basin for sturgeon, and how does that relate to food webs in those pools?

7. What would be the effects of hatchery releases on long-term stock status of wild fish? Ongoing and projected releases of hatchery-reared fish from broodstock may have effects on long-term viability of wild sturgeon populations. How can these potential effects be addressed? What are the comparative benefits and challenges of using wild-caught larvae instead of brood fish on long-term viability of wild populations?

8. How effectively are sturgeon researchers in the Columbia Basin sharing information? On topics such as recruitment, fish passage, and hatchery rearing of larval fish, more cooperation would be beneficial.

198605000 - Evaluate Sturgeon Populations in the Lower Columbia River

Links to: project **and** reports

Proponent: Oregon Department of Fish and Wildlife

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Harvest: What new harvest and escapement strategies can be employed to improve harvest opportunities and ecological benefits within the Columbia Basin while minimizing negative effects on ESUs or populations of concern? Can genetic techniques be used to quantify impacts on wild or ESA-listed stocks in ocean fisheries?
- Population Structure and Diversity: What approaches to population recovery and habitat restoration are most effective in regaining meta-population structure and diversity that will increase viability of fish and wildlife in the Columbia River Basin?

Comment:

This long-standing project provides useful monitoring and stock assessment information for white sturgeon in the Lower Columbia River. It is most directly related to harvest monitoring. It addresses habitat issues and population structure only tangentially. However, the uncertainties are not in general well identified in the reports, and the uncertainties are not a strong focus of the annual report. The emphasis is on trends. The uncertainties could be stated much more explicitly and also framed in a broader context of sturgeon stock assessment and management elsewhere.

There is no conceptual framework provided (e.g., life stages by age, sex and maturation) for understanding data and it relevance. No data are broken out by age, sex, or life stage. There seems to have been limited effort to utilize e data for effective harvest management beyond basic trend data usage. The absence of age determination data makes it difficult to interpret results of length, weight, and maturation data. Despite a sustained effort of agency sampling over many years, the proponents are making only slow progress on understanding the details of sturgeon life history. More detailed efforts focused on specifics and nuances of sturgeon life history would yield benefits, as has been done for other Acipenseriform species (e.g., paddlefish; Scarnecchia et al. 2007, Rev. Fish. Sci. 15:211-263;

Scarnecchia et al. 2011, Rev. Fish. Sci. 19:279-298). These uncertainties do not seem to be adequately appreciated in the report.

There does not seem to be an integrated approach to matching the harvest strategies of a fishery with the data needs for management, resulting in creel assumptions and expansions that make it a challenge to make strong inferences about stock status. Sport fish sampling has presented particular challenges. A more structured (i.e., more spatially and temporally limited, more focused, and more heavily sampled) fishery, with intensive creel sampling of all aspects of biology and physiology would yield benefits. As noted in a previous ISRP review, *one aspect of adaptive management is that regulations can be set to provide a successful positive feedback loop for data acquisition needed for research, monitoring and evaluation. For high valued individual fish such as sturgeon, such restrictions may be more easily justified and defended than for other species.*

Methods: The project report --*White Sturgeon Mitigation and Restoration in the Columbia and Snake Rivers Upstream from Bonneville Dam. Progress Report April 2012- December 2012. Edited by: Christine Mallette, Oregon Department of Fish and Wildlife. Project Number 1986-050-00 Contract Number 63186 May 2014* -- contained four separate chapters or reports. The titles of each report are shown below followed by a brief explanation of the methods used in each of these studies.

REPORT A. Evaluate the success of developing and implementing a management plan for enhancing production of white sturgeon in reservoirs between Bonneville and McNary dams. 1) An update of abundance, life history parameters, and population dynamics of white sturgeon in Bonneville Reservoir, and 2) a summary of annual recruitment of age-0 white sturgeon in four Columbia River reservoirs By Cox, B.S. and S.M. Schade.

REPORT B. Evaluate the success of developing and implementing a management plan to enhance production of white sturgeon in reservoirs between Bonneville and McNary dams. This report includes progress on implementing the fisheries management component of the white sturgeon management plan for the Columbia River between Bonneville and McNary dams including results of surveying 2011 sport and commercial white sturgeon fisheries. By Langness, O.P., D.R. Gilliland, B.J. Cady and B.W. James.

REPORT C. Evaluate the success of developing and implementing a management plan to enhance production of white sturgeon in reservoirs between Bonneville and McNary dams. This report includes results regarding capture and marking efforts in The Dalles Reservoir for white sturgeon population abundance estimates. By B.L. Parker.

REPORT D. Determine spawning interval of white sturgeon in the Columbia River. This report includes a progress update on the maturation cycle in wild white sturgeon By M.A.H. Webb and K.M. Kappenman.

Methods for each report:

REPORT A. Standardized methods for assessment of freshwater fisheries have been developed and are being applied. White sturgeon are sampled with gill nets and set lines. Sampling occurred in Bonneville Reservoir (8 sections) and to a lesser extent in Lower Monument and Little Goose reservoirs. Bonneville

Reservoir data included catch, catch per unit effort, length frequencies, length versus weight relationships, relative weights, annual growth increments, abundance estimate, and age-0 index. Lower Monument and Little Goose reservoirs data included catch, length frequencies, length versus weight relationships, and relative weights. Age-0 indexing data was presented for Bonneville, John Day, and The Dalles reservoirs. Temporal trend data are presented for several metrics. Overall, the methods are sound and yield statistically reliable results. Reasonable measures of accuracy and precision are presented.

REPORT B. Standard creel surveys are conducted on sport fisheries. This report provides results from the 2012 creel surveys for Bonneville, The Dalles, and John Day reservoirs. The commercial/subsistence harvest from Bonneville, The Dalles, and John Day reservoirs is monitored. Tribal commercial fisheries are estimated from poundage reported on fish receiving tickets for each gear type and catch area. Poundage of white sturgeon is converted to numbers of fish by dividing the total poundage by an average fish weight obtained during random biological sampling of treaty Indian commercial landings. Data for the tribal commercial and subsistence harvest from 2012 are presented in this report. The sport fish creel survey methods provide estimates that are relatively reliable, precise, and accurate, but estimates of precision and accuracy are not traditionally included in creel survey results. This is reflected in the presentation of creel survey data in this report for Columbia River reservoirs. The commercial/subsistence harvest data provides a relatively rough index of harvest that is highly dependent on the average fish weight obtained during annual random biological sampling. How “random” samples are obtained from landed fish, sample sizes, and average fish weights are not presented to enable assessment of the precision or accuracy of harvest estimates.

REPORT C. Columbia River Inter-Tribal Fish Commission’s white sturgeon PIT tagging operations for the Bonneville Reservoir, December 5 - 30, 2011, are described. Numbers of white sturgeon captured and PIT tagged are reported. It is not possible to determine the accuracy and precision of recapture data and estimates obtained from them until such data are assimilated and analyzed. The 2012 report states that 4,599 white sturgeon were captured and 3,567 of these were tagged. It is not described how recapture data will be obtained, but this level of tagging effort over several years should yield a substantial proportion of tagged fish in the reservoir.

REPORT D. Montana State University/U.S. Fish and Wildlife Service researchers collected gonadal biopsies from adult white sturgeon in Bonneville Reservoir with Washington Department of Fish and Wildlife. The objective of this research is to describe the maturation cycle in wild white sturgeon above Bonneville Dam and compare the reproductive cycle in that population to that below Bonneville Dam. This (2012) was the first year in this study area. White sturgeon were caught with set-lines. Gonadal tissue was collected by biopsy, and the gonad samples were processed histologically. Preliminary data from a small sample are presented. Measures of precision and accuracy are not appropriate for this small amount of data from a single year.

Program Relevance and Project Results: REPORT A. Status and trend data for white sturgeon stocks in reservoirs are important to assessment of the management program. The various population metrics presented are relevant and yield substantial insights into temporal trends of white sturgeon stocks in reservoirs.

REPORT B. Status and trend data for white sturgeon stocks in reservoirs are important to assessment of the management program. The various catch and harvest metrics presented for both sport fisheries and commercial/subsistence fisheries are relevant and yield substantial insights into temporal trends of white sturgeon stocks in reservoirs.

REPORT C. The PIT tagging efforts will contribute data on movements and survival of white sturgeon in the future. How and when recapture data will be analyzed is not described in the report.

REPORT D. This is highly relevant research needed to understand the reproductive cycles of both male and female white sturgeon in Bonneville Reservoir and to facilitate comparison to other stocks in the Columbia River basin.

Broad Applicability: REPORT A: This report is applicable to management of white sturgeon in the Columbia River. Temporal trend data provide insights into responses of white sturgeon stocks to management actions. Temporal trend data also facilitates testing of the hypothesis that river discharge during spawning affects recruitment of white sturgeon.

REPORT B. This report is applicable to harvest management of white sturgeon in the Columbia River. Temporal trend data on sport and commercial/subsistence fisheries provide insights into responses of white sturgeons to management actions, especially harvest management.

REPORT C. The tag recovery data from this project should yield insights into movements and survival of white sturgeon tagged in Bonneville. These are important insights pertinent to management.

REPORT D. Understanding the reproductive cycles of male and female white sturgeon in various portions of the Columbia River is critical to management of this long-lived fish.

Time Required: It is not immediately clear where the proponents are specifically headed with this work over the next 3-5 years beyond the clear need to continue the population monitoring and harvest management efforts.

REPORT A: This is a long-term effort that needs to be maintained. There can be no endpoint to monitoring and assessment.

REPORT B: This is a long-term effort that needs to be maintained. There can be no endpoint to monitoring and assessment.

REPORT C: This is a long-term effort that needs to be maintained. Use of recapture data from PIT tagged fish will provide survival information that contributes to long-term monitoring and assessment.

REPORT D: Sufficient data should be obtained with 3-5 years of sampling to provide good insight into the reproductive cycles of male and female white sturgeon in Bonneville Reservoir.

200850400 - Sturgeon Genetics

Links to: project **and** reports

Proponent: Columbia River Inter-Tribal Fish Commission (CRITFC)

2006 Research Plan uncertainties addressed:

Direct:

- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?
- Population Structure and Diversity: What approaches to population recovery and habitat restoration are most effective in regaining meta-population structure and diversity that will increase viability of fish and wildlife in the Columbia River Basin?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Additional uncertainty addressed or raised (not in 2006 Research Plan)

- Are observed genetic differences among fish from different reservoir pools indicative of adaptations to specific areas or just the result of recent segregation of putative stocks and thus not of great importance to managers?

Comment:

Methods: This project is aimed at development of a suite of DNA microsatellite loci to study population structure, gene flow, and effective population size in white sturgeon. Summary analyses of basic population genetic metrics such as heterozygosity, conformance to Hardy-Weinberg proportions, and allelic diversity are presented. Sturgeon represent some important challenges to traditional Mendelian approaches because of tetraploid ancestry, long life span, and relatively small sample sizes compared to salmonids studied in the basin. The 2013 report details some preliminary findings regarding population structure and gene flow within the lower Columbia River Basin.

Methods are not described. No analyses were conducted. The proponents report only the samples that were obtained at various locations from 2010 to 2014. It cannot be determined from the information presented if this project will yield statistically reliable results. The report does not provide evidence that this study is closely linked to management needs.

Program Relevance and Project Results: Development of a reliable suite of genetic markers for white sturgeon is a critical step in understanding ecological and evolutionary dynamics of populations in the Columbia Basin, and for future genetic monitoring of stocks in the basin. There should be better justification for use of microsatellite DNA markers, as compared to other marker types, especially SNPs.

The ultimate utility of this program rests on its ability to track a long-lived fish population over many years to fully ascertain some key population parameters.

Although the results to date are consistent with our knowledge of sturgeon movements among reservoirs, it is not clearly specified what further insights can be gained from this work for basic management needs beyond that which is already known or shown. Fish are known to not move much upriver, but more downriver. The low number of brood spawners presents a potential future problem.

Broad Applicability: The power of genetic approaches for addressing critical uncertainties have been demonstrated for many years on salmonids in the basin, but work on non-salmonid species has lagged. A reliable set of genetic markers for long-term genetic monitoring, genetic stock identification (GSI), and eventually parental-based tagging (PBT) is fundamental to addressing uncertainties in non-salmonid species.

It is unclear how results obtained thus far and those anticipated in the future will be used help make decisions needed for sturgeon hatcheries and stock recovery. A critical uncertainty for these fish is: are observed genetic differences among fish from different reservoir pools indicative of adaptations to specific areas or just the result of recent segregation of putative stocks and thus not of great importance to managers?

Time Required: It is not clear why this has to be a 10-year study; it seems to be mostly a developmental project, keeping active until new and improved methods arise. In the interim, applications to management are not well documented and should be clarified.

Microsatellites appear to be well developed. Long-term monitoring will require yearly collections of relatively large sample sizes of sturgeon to obtain sufficient sample sizes to fully capitalize on genetic monitoring approaches.

199502700 - Lake Roosevelt Sturgeon Recovery

Links to: project **and** reports

Proponent: Spokane Tribe

Province/subbasin: Intermountain/Columbia Upper

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?

Comment:

Methods: Larval monitoring and collection methods are well documented and are relatively standard larval sampling methods. Larval density is computed, but measures of variance are not presented.

Fall gill netting methods are also well documented and are relatively standard sampling techniques. CPUE is computed. Length and weight data are used to compute relative weight and absolute and relative growth. Measures of variance are not reported for most of the reported statistics.

Stocked juveniles are marked with PIT tags and scutes are removed so that the origin of sampled juveniles can be determined. This has become standard methodology.

Program Relevance and Project Results: Quantitative objectives for larval collection and juvenile stocking are stated – "The 2012 objectives for the conservation aquaculture program were to collect 10,000 White Sturgeon larvae from the China Bend area in July and transport them to the Sherman Creek Hatchery (SCH). The release target for the U.S. component of the UCWSRI conservation aquaculture program in 2012 was 4,000 juveniles (minimum 30 g)." The approaches used to collect sufficient numbers of larvae and meet subsequent stocking goals should provide substantial input for adaptive management.

Numerous indicators are obtained that can be used in the future to inform statistical models and test hypotheses regarding reservoir operations and larval fish densities or survival of stocked juvenile fish.

The same comments prepared for the Colville Portion of this project apply. Relevance is in addressing the critical uncertainty of why larval fish can be captured in numbers substantial enough to be used for hatchery production but natural recruitment is evidently so low that it cannot be detected. Food web issues and the effects of non-natives on recruitment are critical uncertainties. Another critical uncertainty is the need to develop some sense of the carrying capacity for the system, and to have an approach identified to assess when carrying capacity for sturgeon may have been reached at some future date. Some careful thinking and consultation with other agencies and tribes on this issue, resulting in testable hypotheses, is warranted. Because it is possible that sufficient numbers of larval fish will be captured and reared, large numbers of young hatchery sturgeon could be available for release. Dialogue should be occurring among tribes and states about their possible use in other hatcheries in adjacent areas. Issues of carrying capacity and genetics should be considered as part of this discussion.

Broad Applicability: Any insight into this recruitment problem would have applicability globally in sturgeon recovery. The results of this project have widespread applicability throughout the Columbia River Basin where survival beyond the larval stage is limited and supplemental stocking is considered a viable management option.

Time Required: It will take time to solve this problem. However, the potential benefits and broad applicability of this work make it a project that should be continued into the future.

200811600 - White Sturgeon Enhancement

Links to: project **and** reports

Proponent: Colville Confederated Tribes

Province/subbasin: Intermountain/Columbia Upper

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Mainstem Hydrosystem Flow and Passage Operations: What are the optimal temperature and water quality regimes for fish survival in tributary and mainstem reaches affected by dams, and are there options for hydrosystem operations that would enable these optimal water quality characteristics to be achieved? What would be the effects of such changes in operations and environment on fish, shoreline and riparian habitat, and wildlife?

Indirect or Potential:

- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?

Comment:

This project involves a variety of related activities, including data base management, recruitment indexing, and larval fish sampling, with other agency and tribal cooperators.

Methods: The Colville Confederated Tribes are using standardized methods developed by the Upper Columbia White Sturgeon Recovery Initiative. These are gillnetting and setlines to sample sturgeon. The Tribe is simply conducting field work and contributing data to a large database.

Program Relevance and Project Results: The project is addressing the critical uncertainty of why larval fish can be captured in numbers substantial enough to be used for hatchery production, but natural recruitment is evidently so low that it cannot be detected. Food web issues and the effects of non-natives on recruitment are critical uncertainties also. Some careful thinking and consultation with other agencies and tribes on this issue, resulting in testable hypotheses, is warranted. Although no larval fish were found in 2013, it is possible that sufficient numbers of larval fish will be able to be captured in some years to rear to recruitment large numbers of young sturgeon. Dialogue should be occurring among tribes and states about their possible use in other hatcheries in adjacent areas. Issues of carrying capacity and genetics should be considered as part of this discussion.

Broad Applicability: Any insight into this recruitment problem would have applicability globally in sturgeon recovery**.** It will be a challenge to link the technically complex hydrodynamic model to recruitment, even if it can be linked more immediately to larval transport.

Time Required: It will take time to solve this problem. The work will need to remain focused in order to discover the factors that are limiting natural recruitment in white sturgeon.

198806400 - Kootenai River White Sturgeon Aquaculture Conservation Facility

Links to: project **and** reports

Proponent: Kootenai Tribe

Province/subbasin: Mountain Columbia/Kootenai

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Contaminants: What is the distribution and concentration of toxics, including emerging contaminants, in the Columbia River Basin, and what are/have been their trends over time?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations

Comment:

The Step 2 document provides detailed information on most aspects relevant to this project, more than would be available from just annual reports. The intent is to construct and operate a second hatchery, deemed necessary for the recovery of Kootenai River white sturgeon. Density-dependence is considered and is related to the numbers of fish being reared per year and the carrying capacity of the area being stocked. Most of the uncertainties identified are addressed indirectly. One critical uncertainty addressed is the density of fish to be stocked and whether stocking should occur every year or more sporadically; the latter approach may be perfectly reasonable and adequate for such a long-lived species. Hatchery capacity remains an issue. Most hatcheries in the region have been developed for shorter lived species so the typical approach has been to stock every year, which could lead to density dependent growth and survival.

Another critical uncertainty addressed is the long-term effect of limited brood stock in the long-term viability of the sturgeon produced. Fitness of hatchery-produced salmon or steelhead may be evaluated in a decade or less; sturgeon produced now may not reproduce for a quarter of a century or more.

Methods: Detailed methods are described that document activities. For the density uncertainty, it would be useful for the proponents to thoroughly present how they intend to deal with the potential for density dependence in terms of monitoring and potential responses of their program to density issues.

Program Relevance and Project Results: The proposal lists variables and metrics that will be used to assess white sturgeon or burbot populations following the introduction of hatchery fish into the system. However, there is no information on how the fish will be sampled or the sampling intensity. These are major components of trend monitoring that need to be planned prior to introduction of the hatchery-origin fish.

Broad Applicability: This project has potential applicability to several other sturgeon enhancement and mitigation efforts in the basin and beyond.

Time Required: Progress in 3-5 year timeframe should be adequate.

200200200 - Restore Natural Recruitment of Kootenai River White Sturgeon

Links to: project **and** reports

Proponent: Kootenai Tribe

Province/subbasin: Mountain Columbia/Kootenai

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: What are the impacts of hydrosystem operations on mainstem habitats, including the freshwater tidal realm from Bonneville Dam to the salt wedge? How might hydrosystem operations be altered to recover mainstem habitats?
- Mainstem Hydrosystem Flow and Passage Operations: What are the optimal temperature and water quality regimes for fish survival in tributary and mainstem reaches affected by dams, and are there options for hydrosystem operations that would enable these optimal water quality characteristics to be achieved? What would be the effects of such changes in operations and environment on fish, shoreline and riparian habitat, and wildlife?

- Mainstem Hydrosystem Flow and Passage Operations: What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species and stocks? What are the ecological effects of hydrosystem operations on downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?

Additional uncertainties addressed or raised (not in 2006 Research Plan)

- What are the factors resulting in natural recruitment failure of sturgeon? Is it one, two, or a sequence of factors? How can those hypotheses be tested?
- Will habitat improvements such as improvement in lateral water movements adequately compensate for loss of natural flood peaks deemed necessary for sturgeon recruitment in other localities?
- Is reproduction adequate? Can successful reproduction, when it occurs, be translated into successful recruitment in this altered system?

Comments:

Methods: Methods have expanded to include more food web based evaluation.

Program Relevance and Project Results: Overall, this project has shifted toward a more ecosystem-based effort and away from a more focused effort specifically directed toward understanding factors affecting sturgeon recruitment. The current title of the project is thus misleading. Because of this shift, the work has become less focused and appears to be less hypothesis driven than the original work which focused specifically on sturgeon recruitment. Although there are many benefits to the ecosystem level of understanding, it could be argued that sturgeon recruitment would be a very good measure of ecosystem function. Understanding it would provide insights into that functioning. The critical uncertainty regarding sturgeon recruitment remains.

Comments from a previous ISRP review remain highly relevant: *In 2012, The ISRP requested some additional information regarding the extent to which the 10 recruitment failure hypotheses had been experimentally tested. The response indicated that there has been relatively little experimental testing of these hypotheses. Their relative validity has been assessed by a very highly qualified expert panel using a subjective scoring system. Expert opinion has considerable value, especially if it is applied using an organized process as was done here. However, expert opinion falls quite short of accepting or rejecting a hypothesis based on specific field data. The RM&E effort in the near term should focus on the experimental evaluation of those hypotheses deemed to be most likely limiting sturgeon recruitment.*

Broad Applicability: Knowledge of specific ecological factors, or the sequence of factors, leading to strong year classes of sturgeon would be highly valuable information worldwide. However, progress has been slow.

Time Required: The ecosystem approach now taken might, potentially, result in a better understanding of the factors enabling and preventing recruitment. However, the time frame for this understanding will be longer than for a more focused, hypothesis driven approach. It is not clear based on the evidence presented thus far that this approach will necessarily be successful. Progress should be monitored.

Fish Propagation

Genetics

198909600	Genetic Monitoring and Evaluation (M&E) Program for Salmon and Steelhead	National Oceanic and Atmospheric Administration
200890700	Genetic Assessment of Columbia River Stocks	Columbia River Inter-Tribal Fish Commission (CRITFC)
200900500	Influence of Environment and Landscape on Salmonid Genetics	Columbia River Inter-Tribal Fish Commission (CRITFC)
201002600	Chinook and Steelhead Genotyping for Genetic Stock Identification (GSI) at Lower Granite Dam	Idaho Department of Fish and Game (IDFG)
201003100	Snake River Chinook and Steelhead Parental Based Tagging	Idaho Department of Fish and Game (IDFG)

Summary

Projects listed in the table above all employ genetic monitoring techniques, physical tagging at various life stages, and field and hatchery sampling to examine demographic and life-history changes in salmon stocks related to artificial propagation (AP). Genetic monitoring can help to identify and track changes in hatchery inputs, demographic interactions, benefits from habitat restoration, effects of changing environmental conditions associated with land use, and effects of climate change on hatchery- and natural-origin fish stocks. Ultimately, the goal of genetic studies is to provide insight into the essential management question of artificial propagation: How can benefits to the natural system be maximized and costs be minimized? Genetic monitoring studies usually begin with sampling to establish an (arbitrary) baseline, followed by sampling at regular intervals to evaluate the trajectory of metrics needed to evaluate cost and benefits of AP. Key metrics include the proportion of hatchery-origin fish spawning naturally (pHOS), effective population size and number of breeders, relative reproductive success (RRS), and a variety of indices of (meta) population structure within and among subbasins.

Three general classes of genetic analyses were reported: genetic stock identification (GSI), parent-based tagging (PBT), and studies of environmental response via transcriptomics (RNA-seq) studies. GSI studies, especially when conducted over time, can help quantify straying rates, escapement rates, efficacy of fish passage, metapopulation structure, and other key characteristics of genetic diversity on the landscape. An important development is the transition from microsatellite DNA markers to single nucleotide polymorphisms (SNP) that can be applied widely and consistently across subbasins to allow for more comprehensive assessment of critical uncertainties. Such integration of data and approaches has consistently been raised as an issue in previous reviews of many of the projects in this section.

Based largely on critical uncertainties previously identified in the 2006 Columbia Basin Research Plan, our joint ISAB/ISRP review team identified 11 questions (AP.1 – AP.11) linked to critical uncertainties of AP and its potential effects on natural species, communities, and ecosystems. Answers to all of these questions require unambiguous identification of hatchery-origin (HO) and natural-origin (NO) fish, and most require the ability to assign smolts to HO or NO parents. Conventional tagging approaches have been used to identify HO fish but provide no information about unmarked progeny. In contrast, genetic methods offer a powerful approach to study demographic changes to both hatchery origin (HO) and natural origin (NO) fish, to assign parentage to unmarked smolts, and ultimately, to evaluate relative reproductive success of NO and HO fish. Thus, genetic approaches provide insights that cannot be obtained from physical tagging alone. Further, genetic approaches have great potential to facilitate study of genetic, ecological, evolutionary, and functional changes in focal salmonids (and other fishes) with climate change and other critical uncertainties regarding interactions of NO and HO fishes, straying rates, escapement, land use changes, fish passage, etc. RNA-seq studies can be used to evaluate responses of focal salmonids to increased temperature and other environmental factors likely to accompany climate change.

There is considerable, unrealized potential for synergy by combining data and analyses across these projects to increase the scope and power of inference from GSI and PBT approaches. Such synergy will require standardization of genotyping methods (i.e., incorporation of the same SNP panels for all studies), consistency in scoring, reporting data widely in web-accessible portals, and linking data to environmental databases. Realizing this power will greatly enhance the Program's capacity to address basinwide critical uncertainties surrounding AP effects on metapopulation structure and diversity, ecological performance and resilience, etc. Reports on each project already discuss to some extent efforts to standardize and coalesce subbasin genetic monitoring projects, and more vigorous efforts should be encouraged.

Finally, past ISRP reviews suggest that results of genetic studies (both GSI and PBT) have not been seamlessly incorporated into fish propagation management practices. Genetic criteria are used to establish and monitor: (1) rates of refreshment of hatchery brood stock with native stock, (2) the effects of genetic drift and selection associated with hatchery rearing, and (3) hybridization of HO and NO fish and its effects on performance, survival, fecundity, and other proxies for fitness. Lead researchers need to communicate concrete recommendations based on genetic data and analyses. Many of the genetic studies conducted in the Columbia Basin, however, are at the forefront of establishing genetic methods, techniques, and analyses that have been adopted by fishery programs throughout the world. Thus, some of these studies and ancillary products have had enormous impact on the establishment and development of conservation hatcheries and best management practices.

198909600 - Genetic Monitoring and Evaluation (M&E) Program for Salmon and Steelhead

Links to: project **and** reports

Proponent: National Oceanic and Atmospheric Administration

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Indirect or Potential:

- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations

Comment:

Reports are centered on results of genetic monitoring of juvenile and adult Chinook and steelhead of hatchery and wild origin. This project directly addresses three of the 2006 critical uncertainties at the subbasin (Snake River) scale by establishing a genetic monitoring protocol to track key metrics of Snake River salmonids over time. It provides a baseline and response curve to evaluate management and habitat restoration effects on productivity and resilience of focal salmonid populations. This project will indirectly address the fourth and fifth critical uncertainties listed above if results can be synergized with others in the Columbia River Basin. It also indirectly addresses the sixth critical uncertainty by establishing a time series of relative reproductive success (RRS) of HO fish.

The project also directly addresses key Fish and Wildlife Program questions: (1) are hatchery improvement programs and actions achieving the expected biological performance objectives? (2) What are the effects of artificial propagation on the viability of wild fish populations?

Methods: The study currently employs a well-developed microsatellite DNA protocol but is transitioning to Single Nucleotide Polymorphisms (SNPs) in concert with other major genetic-monitoring programs in the Basin. A time-series approach is being used to study general trends in effective population size and genetic diversity of salmonid stocks, together with more focused studies of relative reproductive success (RRS) of hatchery and wild origin fish at targeted locations. The project also assesses population structure (i.e., GSI) of target salmonid species and ESUs in the Snake River Basin using standard and well-reasoned approaches and sampling design. Accepted methods are used for the project and statistically reliable results are being produced. Confidence intervals, means and standard errors were shown in some of the annual report’s figures. Forty-two reports, manuscripts, or book chapters, many peer-reviewed, were produced from project data. One aspect of the study that requires some more detail is how the project will transition to a SNP-based genetic marker system and retain continuity with older data sets to maintain the time series.

Program Relevance and Project Results: Since its inception in 1989, this project has made and continues to make significant contributions toward increasing understanding of the potential effects of hatchery programs on the genetic structure of adjacent conspecific populations and in supplemented populations. The methods being employed could be exported to other parts of the Columbia Basin and used on different species, for example coho and chum salmon. Another important finding of this study is that RRS based on smolt production appears to be comparable to that based on adult returns. If confirmed, this result would lead to quicker evaluations of RRS and statistically more robust studies because of the greater ease of collecting samples from juveniles as opposed to scarcer adults. This type of monitoring work is now an essential part of hatchery reform and the goal of using widespread hatchery propagation in recovery of natural populations. Results show cases where hatchery fish seem to have contributed to natural production and cases where the genetic effects of the hatchery supplementation are less apparent. This project directly addresses RPA #182 and RPA #184.

Some status and trend data are produced by the project as abundance, migration timing, and age structure of juvenile steelhead originating from Little Sheep Creek is estimated annually by ODFW. Some of these fish are collected and used in the genetic assessments made by the project. It was not stated whether this information is used to estimate SARs or used in other types of analyses.

Broad Applicability: This study has been key to understanding evolutionary relationships of salmon stocks in the Snake River and is delivering high-impact publications and new insights on demographic, ecological, and evolutionary processes of these stocks that are broadly applicable to design, implementation, and management action based on genetic monitoring studies. Work on reproductive success provides some of the best data available on interactions and ecologies of hatchery-produced fish and natural counterparts. Each species as well as each system experience a unique combination of factors specific to that location and hatchery program (habitat, temperature regimes, return timing, migration distance, acclimation/release protocols, etc.). Consequently, results from a single study should not be applied across all species and programs. As more results accumulate, and the project transitions to a SNP genotyping protocol, valuable comparisons and powerful meta-analyses should be possible. For example, in this study, estimation of RRS over time shows dramatic differences in the performance of hatchery fish that could be linked to environmental/habitat variation. Integrating across RRS studies (conducted over the same time frames) could reveal whether general relationships of demographic and environmental parameters and RRS exist, and, if so, whether these relationships are general to the whole system and across species.

Time Required: Data presented in the annual report indicate that significant yearly variation in RRS values in hatchery and NORs has occurred. It is also suggested that species and watershed effects may influence the results of RRS studies. For these reasons it is important that studies like this one be continued for multiple years. This will help account for yearly variation and will also help delineate the possible effects of continued exposure to hatchery conditions on the reproductive success of hatchery fish reproducing in nature. Even small differences in reproductive success can accumulate over years, however, so continued monitoring of supplemented populations is critical. Genetic monitoring programs have deep spatial and temporal scope and goals. Detection of long-term trends in genetic diversity require time series that are decades long and should continue as long as salmon populations are not self-sustaining. Evaluation of reproductive success is a linchpin of understanding demographic interactions of hatchery-produced and natural stocks.

200890700 - Genetic Assessment of Columbia River Stocks

Links to: project **and** reports

Proponent: Columbia River Inter-Tribal Fish Commission (CRITFC)

2006 Research Plan uncertainties addressed:

Direct:

- Harvest: What new harvest and escapement strategies can be employed to improve harvest opportunities and ecological benefits within the Columbia Basin while minimizing negative effects on ESUs or populations of concern? Can genetic techniques be used to quantify impacts on wild or ESA-listed stocks in ocean fisheries?

Indirect or Potential:

- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?

- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Comment:

The project reported directly only on the critical uncertainty related to genetic-based stock proportions in harvests and escapements past dams. However, the stock identification methods developed in this project will be invaluable for addressing virtually all critical uncertainties surrounding high level indicators of artificial production, mainstem hydrosystem, and population structure and diversity. Key uncertainties that SNP-based PBT will indirectly address are indicated above.

Although not directly addressed, these methods have great applicability for evaluation of density dependence through estimates of population size, percent of hatchery origin fish on spawning grounds (pHOS), and other metrics.

Methods: Sound methods were employed to: (a) discover and evaluate potential SNP markers in salmon, steelhead, and lamprey that could be used for stock identification,(b) expand existing genetic baselines for natural origin (NO) and hatchery origin (HO) fish where parent-based tagging (PBT) has occurred, (c) implement Genetic Stock Identification (GSI) programs for mainstem Chinook and steelhead fisheries, and (d) estimate the arrival timing and abundance of steelhead, spring Chinook, and sockeye adults when they passed over Bonneville Dam. How analyses were performed and the accuracy and precision (95% CIs) of results were appropriate. This project combines GSI with PBT to evaluate harvest and fish passing Bonneville Dam. Assignment testing and PBT analytical methods are statistically sound, although PBT requires more empirical testing and further evaluation of field performance. Numerous peer-reviewed publications have been produced from the data generated by the project, and the proposal was reviewed favorably by the ISRP (2008).

Program Relevance and Project Results: The project is management oriented. For example, the genetic baselines established by the project and its capacity to ascertain stock origins has allowed the identification of fish caught in mixed stock fisheries in the Columbia River. The project demonstrates the feasibility of PBT methods to track the arrival timing and make abundance estimates of hatchery and NO spring Chinook, steelhead, and sockeye as they passed over Bonneville Dam. Additionally, SNP-based genotyping was used to identify the origin of steelhead harvested in an ocean fishery. These tools could potentially be used to address some aspects of the two Harvest Uncertainties shown above. A SNP panel was developed that can be used to identify the origin of lamprey stocks. More generally, this project will improve capabilities to distinguish specific stocks, to determine genetic diversity and stock specific run timing, and to estimate stock composition to provide information for fisheries management and harvest. Newly discovered SNP markers may also be useful for other applications such as pedigree studies for estimating reproductive success and evaluating adaptive divergence of populations to specific environments. Results from this project corroborate that SNPs perform at least as well as microsatellite DNA markers (µSATs) in terms of their potential for monitoring population composition of fish migrations and fisheries harvests. In addition, SNPs offer an opportunity to characterize adaptive variation, which is beyond the scope of most µSAT datasets that utilize neutral markers. Most importantly, the study has demonstrated that substantial improvement in accuracy and increased information can be obtained by using GSI and PBT in combination, particularly for estimating stock composition of mainstem Columbia River Chinook salmon and steelhead fisheries. PBT also improves the accuracy for defining hatchery-origin and natural-origin stocks.

Broad Applicability: PBT is a potentially revolutionary approach for mass tagging fish, and development of well-tested SNP panels for major fished stocks in the Columbia River Basin will be a major step forward in understanding the interactions of hatchery and naturally produced fish and effects of dam operations and fish passage on returns. Studies at finer geographic scales could take advantage of this technology to evaluate local reproductive success and carrying capacity. Finally, SNP analysis combined with genomic and physiological work could be used to explore adaptation of stocks to local environmental conditions and will be helpful in tracking Columbia River salmon wherever they occur (e.g., on the high seas or in marketplaces).

Time Required: The methods will continue to improve as baseline collections are expanded and statistical techniques are refined. To make PBT more relevant to fisheries management, it will be important to establish a protocol for expanding PBT stock proportions and for estimating total abundance of harvested stocks. Such a protocol is currently being developed and will be available for future years. Currently SNP panels for steelhead, spring Chinook, sockeye, and lamprey have been developed and refinements/additions to them may occur. Additionally panels for fall Chinook, coho, and other species could be added to or developed.

Contributions to mixed stock fisheries and data on arrival timing and abundance of steelhead, spring Chinook and sockeye stocks passing over Bonneville will likely need to be assessed on a yearly basis into the foreseeable future to help track trends in stock abundance and facilitate or modify harvest management.

200900500 - Influence of Environment and Landscape on Salmonid Genetics

Links to: [project]() **and** [reports]()

Proponent: Columbia River Inter-Tribal Fish Commission (CRITFC)

2006 Research Plan uncertainties addressed:

Direct:

- Climate Change: Can integrated ecological monitoring be used to determine how climate change simultaneously affects fish and wildlife and the freshwater, estuarine, ocean, and terrestrial habitats and ecosystems that sustain them?
- Climate Change: What long-term changes are predicted in the Columbia River Basin and the northeast Pacific Ocean, how will they affect the fish and wildlife in the region, and what actions can ameliorate increased water temperatures, decreased summer river flows, and other ecosystem changes?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Indirect or Potential:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Comment:

Although data presented in reports are preliminary, this project directly addresses three of the 2006 critical uncertainties related to identifying and quantifying genetic and physiological responses of salmonids to temperature changes. Further, the landscape genetics approach adopted in this project has great potential to address other critical uncertainties related to local adaptation, metapopulation structure (and its restoration), genetic diversity, and effects of artificial production on natural origin populations, etc.

Methods: Two types of data are gathered for this project. First, SNP data (described in a number of other studies being performed by this research group) are used to evaluate gene loci in focal salmonids that appear to be candidates for diversifying selection across the landscape. This is done by comparing levels of divergence across SNP loci to identify loci that have significantly higher values of F_{ST} than those that appear to be evolving neutrally. Loci that are more divergent than expected are deemed "candidate" loci for studying genetic diversification on the landscape and potentially identifying targets of local selective regimes. The second type of data is generated by RNA-seq that involves identifying and quantifying the amount of messenger RNA present in fish under experimental conditions. In this case, a desert strain of redband trout was compared to a high mountain strain under the same environmental conditions to identify differences in gene expression levels among strains. The RNA-seq approach focuses on differential expression of genes across strains to identify genetically determined differences in physiological responses, although these responses may have a genetic basis or represent “plasticity” in the scope of response. The experimental study described here aims to understand the basis of the response to thermal differences.

Program Relevance and Project Results: The project’s specific objectives are: (1) Landscape Genetics - determine correlation of watershed characteristics such as elevation, barriers, migration distance, and temperature to genetic structure of Chinook salmon and steelhead populations; and (2) Expression of Traits - evaluate how environmental conditions influence the genetic expression of physiological traits (i.e., smoltification and thermal tolerance) that are related to recovery of steelhead populations. These objectives are linked to the uncertainty about the genetic structure of steelhead and Chinook populations in the Basin and whether differences in non-neutral genetic variation exist in these populations. A controlled rearing study using desert and montane redband trout and F1 crosses showed that the desert fish possessed genes that adapted them to warm aquatic habitats.

No status and trends information is produced by the project. However, this study could contribute to such work since the SNPs identified will most likely be incorporated into the GSI baseline used to identify steelhead and Chinook populations or geographic groups in the Columbia Basin making it possible to track these population units.

Broad Applicability: Both aspects of the project, the determination of genetic diversity in Chinook and steelhead throughout the Columbia Basin and the identification of non-neutral genetic variation in populations of these fishes have broad applicability. Discovering new SNPs will likely lead to greater refinements in stock identification. Linking non-neutral SNP loci to adaption may be important in the future if new areas of the Basin are opened up to fish introductions. It might be possible, for example, to match potential donor stocks with certain adaptive traits (e.g. tolerance to warm water, migration timing etc.) to newly available habitats to increase the likelihood they would eventually establish self-sustaining populations. This project has broad potential to predict impacts of climate change to the extent that thermal preference has a genetic basis in focal salmonid species and thus addresses key critical uncertainties related to climate change. The methods being developed and tested are broadly applicable throughout the Columbia basin.

Time Required: It is difficult to assess how long work of this type of research should continue, but other salmonid species like bull trout, sockeye, chum, fall Chinook, and coho could benefit from similar efforts. It is likely that a long-term effort will be required before these techniques will have any special advantages of practical value for management and recovery of populations over conventional approaches to inferring the existence of adaptive traits (e.g., correlative studies and common garden experiments). Other studies and projects aimed at phenotypic and physiological variation (i.e., common-garden experiments) should include routine genotyping, and if possible, take RNA samples for RNA-seq.

201002600 - Chinook and Steelhead Genotyping for Genetic Stock Identification (GSI) at Lower Granite Dam

Links to: project **and** reports

Proponent: Idaho Department of Fish and Game (IDFG)

Province/subbasin: Blue Mountain/Grande Ronde, Blue Mountain/Imnaha, Columbia Plateau/Snake Lower, Mountain Snake/Clearwater, Mountain Snake/Salmon

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles and from harvest in fisheries targeting hatchery-origin adults?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Indirect or Potential:

- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?
- Population Structure and Diversity: What are the differential effects of flow augmentation, transportation, and summer spill on “ocean type vs. reservoir type” fall Chinook?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Comment:

Although this project focuses on development and standardization of genetic methods and is somewhat preliminary, three of the 2006 critical uncertainties (listed above) are directly addressed. Other uncertainties could also be addressed with the SNP-based genetic stock identification (GSI) and parent-based tagging (PBT) methods being refined by this project. Ongoing standardization and synergy across PBT projects in the basin is an important development, and once implemented could address many critical uncertainties related to AP effects on natural systems, fish passage and water operations, habitat restoration, and climate change.

Methods: Appropriate methods are being used to discover new SNPs for genetic stock identification, to upgrade existing GSI baselines, and to implement GSI to assign individual adult and juvenile fish to Snake River genetic stocks. For example, when new SNPs were evaluated for inclusion into the GSI baselines for Snake River steelhead and spring/summer Chinook salmon, statistical analyses were used to test for Hardy Weinberg equilibrium, linkage disequilibrium, information content of SNP markers, genetic diversity, presence of outlier loci, and genetic population structure via fixation indices. Also, when existing GSI baselines were updated, self-assignment evaluations were performed to ensure that assignment accuracy had not been impaired. Thus, this project tests the applicability and efficacy of SNP panels for large-scale genotyping and Genetic Stock Identification for chinook and steelhead as proof of concept for adoption of SNPs as an efficient and widely applicable genotyping approach. This proposal was reviewed favorably by the ISRP (2010).

Program Relevance and Project Results: The project addresses significant management needs and uncertainties. In the past, data on population abundance, age composition, genetic diversity, recruits per spawner and survival rates for Snake River steelhead and spring/summer Chinook populations were difficult to obtain because of the remoteness of spawning locations and environmental conditions such as river flows and turbidity. The project's GSI and PBT baselines, along with collaborative efforts with the ISEMP project, are now making it possible to gather such data on a genetic stock and geographic basis for both species. Information being gathered by the project will be used to monitor the status and trends in abundance, productivity, and genetic diversity in Snake River natural and hatchery (NO and HO) steelhead and spring/summer Chinook. Changes in abundance and genetic diversity, two high level indicators, will be tracked in Snake River steelhead and spring/summer Chinook salmon. More generally, the project will improve capabilities to distinguish specific stocks, to determine genetic diversity and stock specific run timing, and to estimate stock composition to provide information for fisheries management and harvest.

Broad Applicability: The methods being developed and tested are, by design, broadly applicable in the Columbia Basin and will be helpful in tracking Columbia River salmon wherever they occur (e.g., on the high seas or in marketplaces). PBT, GSI, and incorporation of PIT tag detection information from ISEMP tributary arrays could be used effectively in concert to estimate abundance and other demographic parameters of adult fish. The proponents are planning on incorporating genetic samples from in-river fisheries to refine run reconstruction efforts for Snake River steelhead and Chinook. A similar approach could be used on populations originating from other subbasins. Such a combined effort would help delineate the occurrence of straying as well as assist in basic status and trends monitoring. This research is potentially transformative in that it capitalizes on new technology to capture genome-level responses to environmental change and management actions. High throughput SNP analysis could be widely adopted throughout the Basin and has the potential to link ecological performance and genetic diversity. The program described here has the potential to capitalize on the genomics revolution by linking variation in SNPs located in key genes to ecological performance by annotating SNPs to the salmonid genome.

Time Required: The methods will improve as baseline collections are expanded and statistical techniques are refined. Thus, to be maximally effective this effort will need to be conducted into the foreseeable future. GSI baselines should be upgraded and evaluated on a regular basis and individual assignments will need to be made on adults and juveniles on an annual basis to track trends in abundance and other parameters. Once fully developed, SNP protocols should be implemented in monitoring efforts throughout the basin. One major challenge is the continuity of the time series of genetic monitoring in the Snake River Basin that began in 1989. Future efforts should seek to reconcile data sets from allozymes, to microsatellites, to SNPs.

201003100 - Snake River Chinook and Steelhead Parental Based Tagging

Links to: project **and** reports

Proponent: Idaho Department of Fish and Game (IDFG)

Province/subbasin: Blue Mountain/Grande Ronde, Blue Mountain/Imnaha, Columbia Plateau/Snake Lower, Mountain Snake/Clearwater, Mountain Snake/Salmon

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Harvest: What new harvest and escapement strategies can be employed to improve harvest opportunities and ecological benefits within the Columbia Basin while minimizing negative effects on ESUs or populations of concern? Can genetic techniques be used to quantify impacts on wild or ESA-listed stocks in ocean fisheries?

Indirect or Potential:

- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Habitat Estuary, Plume and Ocean: What is the significance to fish survival, production, and life-history diversities of habitat degradation or restoration in the estuary as compared with impacts to other habitats in the basin? How does this partitioning of effects vary among species and life-history types?
- Habitat Estuary, Plume and Ocean: What are the highest priority estuarine habitat types and ecological functions for protection and restoration (e.g., what are most important habitats in the

estuary for restoring and maintaining life-history diversities of subyearling Chinook and chum salmon, and how effective were past projects in restoring nursery/feeding areas?

- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Comment:

The project reports directly only on the critical uncertainty related to identification of hatchery fish by hatchery and family caught in fisheries, or sampled in escapements past dams and as broodstock. However, the genetic stock identification (GSI) and parent-based tagging (PBT) methods developed in this and companion projects (above) will be invaluable for addressing all critical uncertainties listed above if sufficiently adopted and integrated across Columbia Basin genetics programs.

Methods: Accepted protocols are used to extract DNA from broodstock and from unknown samples obtained from fisheries, spawning grounds, or other areas. When genotypes were obtained from samples, published methods were used to test for null alleles, PCR artifacts, estimate genetic diversity, genetic structure and sex. Quality control measures were used to determine which samples could be added to the PBT SNP data set and error rates were estimated by re-genotyping 166 steelhead and 365 Chinook samples taken from the broodstock collections. Assignments of unknowns are being accomplished via SNPPIT software obtained from NOAA Fisheries Southwest Science Center. SNP technology offers the potential to track specific families. Also genotyping with SNPs is less ambiguous than it is in microsatellites making it more transferable to different labs doing GSI and other genetic applications. Compilation of these data into a single database available to all researchers would be a crucial next step to the program.

Program Relevance and Project Results: Parentage Based Tagging (PBT) could help to address Fish and Wildlife Program objectives that involve marking hatchery stocks, conducting hatchery evaluations and reform, and enforcing salmonid fishery management measures. This project continues to sample and inventory nearly 100% of hatchery broodstock for steelhead (~5,500 individuals annually) and spring/summer Chinook salmon (~8,000 individuals annually). Results to date indicate that annual sampling, inventorying, and genotyping of all steelhead and spring/summer Chinook salmon broodstock in the Snake River basin is feasible and that the SNP sets identified for PBT are sufficient for accurate assignment of offspring to brood year and hatchery stock, thereby allowing an unprecedented ability to mark millions of Snake River smolts and an opportunity to address future objectives of parentage-based management. PBT baselines for both species were used to determine the origin of fish sampled in sport fisheries, during migration, and in broodstock collections for real-time management of spawning. The number and diversity of studies that made use of the PBT baselines is noteworthy, especially since many of these studies would not have been possible without access to this technology.

This project is closely linked with projects 2008-907-00 and 2010-026-00, and most of the same comments regarding uncertainties apply. The ISRP (2010) noted: “One concern is that the ISRP could not determine whether this proposed project unnecessarily duplicates work already being performed or proposed by other BPA-funded projects”. However, this concern should be balanced against the need to fully integrate genetic monitoring programs in the Columbia River Basin. Basinwide integration of SNP-based screening methods, GSI and PBT are essential for full utility in addressing critical uncertainties at a variety of spatial scales.

Parentage assignment offers enormous potential to address key uncertainties regarding the effects of hatchery-produced fish by improving marking techniques. Ecological measures such as abundance (based on captures) could be employed, as could stream surveys to evaluate local percentages of hatchery and natural counterparts. Accurate estimation of the proportion of hatchery-origin fish among natural spawners (pHOS) is a key metric for understanding AP effects on natural populations. PBT methods could also provide powerful assessments of habitat, climate change, etc. on natural origin vs. hatchery origin fish.

Broad Applicability: The methods being developed and tested are, by design, broadly applicable throughout the Columbia Basin, and will be helpful in tracking Columbia River salmon wherever they occur. The PBT SNP data sets are restricted to Snake River hatchery steelhead and spring/summer Chinook. The concept however, could be broadly applied throughout the Columbia Basin. This program has potentially transformative potential as a means to conduct massive tag and recapture data at a variety of spatial scales and levels of genetic relatedness (i.e., variance in reproductive success among families). This may be one of the first large-scale tests of the theoretical approaches, so there is some risk.

Time Required: SNP-based genetic monitoring methods will continue to improve as baseline collections are expanded and statistical techniques are refined. Sample processing and results appear to be produced in a timely fashion, which addresses a major concern of the ISRP review. The identification of hatchery origin fish will be an ongoing need, and because SNP sets will need to be upgraded and assessed on a regular basis, it is expected that this work will be continued into the foreseeable future.

Relative Reproductive Success

200303900	Monitor and Evaluate (M&E) Reproductive Success and Survival in Wenatchee River	National Oceanic and Atmospheric Administration, Washington Department of Fish and Wildlife (WDFW)
200305400	Evaluate the Relative Reproductive Success of Hatchery-Origin and Wild-Origin Steelhead Spawning Naturally in the Hood River	Oregon State University
200306300	Natural Reproductive Success and Demographic Effects of Hatchery-Origin Steelhead in Abernathy Creek, Washington	US Fish and Wildlife Service (USFWS)
200729900	Investigation of Relative Reproductive Success of Stray Hatchery & Wild Steelhead & Influence of Hatchery Strays on Natural Productivity in Deschutes	Oregon Department of Fish and Wildlife
201003300	Study Reproductive Success of Hatchery and Natural Origin Steelhead in the Methow	Washington Department of Fish and Wildlife

Background

Studies to evaluate the relative reproductive success (RRS) of natural-origin (NO) adults versus hatchery-origin (HO) adults spawning in the wild are needed to assess the status of natural populations that comprise a mixture of natural origin and hatchery origin spawners, to determine the net benefits of supplementation, and to develop procedures to reduce costs to natural populations that result from interactions with hatchery origin fish. The five projects reviewed here (listed above) all use recent advances in genetic parent-based tagging (PBT) methods to measure relative reproductive success in naturally spawning fish. These projects directly address three of the 2006 critical uncertainties related to Fish Propagation:

- What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?

Research Results

One project has focused on a spring Chinook population in the Wenatchee River since 2003. The other projects focus on steelhead populations in the Hood River and Abernathy Creek, both since 2003, in the

Deschutes River since 2007, and the Twisp River since 2010. Results from the two most recent studies are still too preliminary or incomplete to discuss here. However, results from the three projects initiated in 2003 consistently indicate that natural spawning fitness (i.e., the reproductive success of natural spawners) is lower for hatchery origin fish than for natural origin fish. Natural spawning fitness of hatchery spring Chinook salmon in the Wenatchee River was only about half that of natural-origin Chinook. In this case, the choice of spawning location explained much (but not all) of the reduced fitness. In Hood River steelhead, the observed reduction in natural spawning fitness was determined to be a consequence of rapid genetic change due to hatchery conditions. The Abernathy Creek study demonstrated substantial negative effects on genetic diversity and the scope of physiological response associated with hatchery origin fish that spawned naturally. Natural spawning fitness was lower for hatchery origin fish than natural origin fish in most study years, but small sample sizes and substantial proportions of non-sampled parents (less than 10% of returning fish were matched with both of their parents) precluded strong conclusions regarding relative reproductive success.

To investigate whether reduced fitness of early-generation hatchery fish is a general phenomenon, the Hood River project also included a broad review of six other studies on four salmon species. The reviewers concluded that both theoretical and empirical evidence now strongly suggests that rapid adaptation to the hatchery is a sufficient explanation for the fitness declines observed in first- and second-generation fish when they spawn in the wild.

Because of these findings, the proponents are now shifting the focus of these projects to ascertain the mechanisms causing reductions in natural spawning fitness, the extent to which the causes are genetic, and how the consequences might be ameliorated. Differences in natural spawning fitness of Wenatchee Chinook salmon were influenced by age and size at spawning, and hatchery origin spawners differed from naturally produced fish in most of the 15 traits examined. A study of gene expression in Hood River steelhead found that fry produced from hatchery origin parents expressed a suite of genes associated with responses to stress and disease differently than fry produced from natural origin crosses, a difference that is hypothetically attributed to selection pressures associated with the occurrence of pathogens, wounding, and generalized stress in the hatchery. That project is also addressing how density-dependent selection pressure in the hatchery might affect the overall fitness of returning fish by increasing the variability in performance among families in the hatchery environment. Genomes of Hood River fish of hatchery and wild ancestry are being scanned to determine what genes respond to selection.

The conservation hatchery practices implemented and studied in the Abernathy Creek project appear to have been inadequate to maintain the genetic integrity of the hatchery origin population. Substantial genetic drift occurred in spite of incorporating natural origin spawners into the hatchery brood line. As a result the hatchery component was less genetically diverse and became differentiated from the natural origin component. Smolt production was neither positively nor negatively affected by the hatchery when compared to control streams. Hatchery and natural origin smolts emigrated out of Abernathy Creek with similar timing but they differed physiologically and morphologically such that hatchery origin smolts have been less prepared to emigrate into saltwater.

Replication, Gaps, and Longevity of Studies

The 2000 BiOp called for two studies of relative reproductive success (RRS) per ESA-listed evolutionarily significant unit (ESU) or distinct population segment (DPS). The follow-up 2008 BiOp called for continuing RRS investigations for spring Chinook in the Wenatchee River and Grande Ronde River subbasins and steelhead in the Hood River subbasin. Additionally, a steelhead RRS study was identified for the Methow River and a fall Chinook RRS study in the Snake River.

Studies of relative reproductive success initiated in 2003 to fulfill the 2000 BiOp RPA did not cover the entire range of ESA-listed ESUs. The scope of RRS investigations was then reduced in 2008 (without explanation) from the level in the 2000 BiOP. The current Fish and Wildlife Program investigations provide coverage of all but the Snake River fall Chinook RRS study that were identified in 2008 BiOp RPA 64.

An additional RRS investigation has since been initiated through CRITFC Accord Proposal 200900900. That project provides genotyping and analysis for the Nez Perce Tribe's Johnson Creek spring Chinook supplementation project (JCAPE, 199604300) and supports RRS studies for spring Chinook and coho salmon reintroduction projects. RRS studies of various scopes are conducted on spring Chinook within the Idaho Supplementation Studies (199809800) and Yakima River Monitoring and Evaluation (199506325). RRS studies of steelhead are continuing in the Kalama and Wenatchee rivers using Mitchell Act and PUD funding respectively. RRS studies of coho and chum salmon are also ongoing outside of the Columbia River Basin.

Thus, there appears to be reasonable replication of studies of steelhead and spring Chinook salmon that have an extended stream life history type. What seems to be needed is a RRS study of Snake River fall Chinook that have an ocean life history type, and discussion among scientists and managers about whether RRS studies of Columbia River coho and chum salmon are warranted.

The ISRP/AB are not aware of any feasible procedure to ascertain the amount of replication that is needed, in terms of the number of streams or generations, to fully capture the range and variation in relative reproductive success between hatchery and natural origin salmon and steelhead. Based on the empirical evidence that is accumulating, it seems that at least two, and probably not more than three, salmon generations should be observed in multiple systems for different life-history types to provide reasonable estimates of the important parameters.

Coordination and Integration of Projects

The ISRP/AB suggest that studies of relative reproductive success in salmonids could be coordinated to systematically search for mechanisms causing the observed differences in fitness of natural origin and hatchery origin fish, and to determine the relative importance of phenotypic, genotypic, and environmental factors. There appears to be considerable potential for synthesizing results among existing projects, and that effort should be given high priority.

200303900 - Monitor and Evaluate (M&E) Reproductive Success and Survival in Wenatchee River

Links to: project **and** reports

Proponent: National Oceanic and Atmospheric Administration, Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Columbia Cascade/Wenatchee

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Indirect or Potential:

- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Comment:

This project directly addresses several of the 2006 critical uncertainties about fish propagation because it is specifically designed to measure relative reproductive success of hatchery and natural origin Chinook spawning in the natural environment. First, the project is evaluating changes in the natural spawning fitness of supplemented populations, as well as examining possible reasons for such changes. Second, measuring the extent of changes in fitness is a critical step in evaluating the magnitude of any demographic benefit to natural production from supplementation. Third, understanding the mechanisms for those changes is important when developing supplementation procedures that will reduce deleterious interactions between hatchery-produced and naturally produced salmon.

Results from this project could also potentially address uncertainties about population structure and diversity related to the effects of artificial production on functional metapopulation structure (because straying rates are specifically examined), and the relationship between genetic diversity and ecological and evolutionary performance (because genetic diversity and reproductive success are both examined).

Methods: Accepted methods are being used to trap, sample, and enumerate downstream juveniles and returning adults. DNA-based pedigree procedures are employed to identify and enumerate smolts and adults produced by hatchery and NO spring Chinook spawning in nature and the number of adult progeny produced by both types of fish when they are placed into the hatchery are also identified and counted. The panel of loci being used for pedigree assessments was shifted from microsatellites to single-nucleotide polymorphisms (SNPs) beginning with adults returning in 2010. Pedigree assignments based on microsatellites and SNPs were performed on the 2010 fish to determine if both types of genetic variation provided similar origin assignments. Biological traits on returning adults are being collected along with straying rates within and outside of the Wenatchee Basin. Methods to perform this work meet scientific standards as data produced from the project have been used in peer-reviewed publications.

Program Relevance and Project Results: This project studies the relative reproductive success of naturally spawning hatchery and natural spring Chinook salmon in the Wenatchee River above Tumwater Dam. The study was initiated in 2003 in response to the 2000 BiOp RPA 182 to (1) directly measure the relative reproductive success of hatchery and natural-origin Chinook salmon in both natural and hatchery settings, (2) determine the degree to which any differences in reproductive success between hatchery and natural Chinook salmon can be explained by measurable biological characteristics such as run timing or size, and (3) estimate the relative fitness of hatchery-lineage Chinook salmon after they have experienced an entire generation in the natural environment.

Results indicate substantially reduced (~50%) reproductive success of hatchery spring Chinook salmon relative to natural-origin salmon in this watershed. Choice of spawning location appears to explain much but not all of the reduced fitness of hatchery fish spawning naturally. Reproductive success increases with distance upstream in the watershed, and most hatchery fish spawn low in the watershed, near the site of their release. RRS values of spawners from brood years 2004-2007 were also influenced by the age and size of the hatchery fish. Artificial propagation produced fish that differed from naturally produced fish in most of the 15 traits examined.

No formal status and trends analyses are reported. The project, however, has tracked smolt and adult production by fish spawning in nature and artificially in a hatchery, so it should be possible to track trends in abundance by the genotype of parents and by where they spawned. High Level Indicators associated with the project include abundance, productivity, and spatial distribution.

Adaptive Management is occurring. For example, based on project results the number and types of hatchery fish allowed to spawn under natural conditions are being adjusted. Culling of hatchery fish at Tumwater Dam prior to entering natural spawning areas began in 2013 and will last until 2015. Additionally, a future goal of the project is to determine how or if alterations in hatchery operations and practices can be carried out to minimize hatchery effects on progeny production when hatchery fish spawn under natural conditions.

Evaluation of density dependence is not reported but may be feasible.

Broad Applicability: It is not yet clear whether results from this study alone would apply beyond the Wenatchee River. However, similar studies are being conducted elsewhere, and if replicated, results would apply broadly to spring Chinook in the Columbia Basin. Synthesis of results among projects evaluating relative reproductive success of salmonids should be given high priority. Similarly, the relative influence of phenotypic, genotypic, and environmental factors in determining reproductive success should continue to be listed as a critical uncertainty.

Time Required: Annual reporting is up to date (last report was for 2014) and provides summary data and retrospective discussion of all results to date. As well, a number of primary publications have been produced (abstracts provided). Field work is expected to end in 2020 — five years from now. Additional analyses of data are necessary and will likely be completed several years after 2020.

200305400 - Evaluate the Relative Reproductive Success of Hatchery-Origin and Wild-Origin Steelhead Spawning Naturally in the Hood River

Links to: project **and** reports

Proponent: Oregon State University

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Indirect or Potential:

- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Comment:

The project directly addresses several of the 2006 critical uncertainties about fish propagation because it is specifically designed to measure relative reproductive success of hatchery and natural origin steelhead spawning in the natural environment. First, the project is evaluating changes in the natural spawning fitness of supplemented populations, as well as examining possible reasons for such changes. Second, measuring the extent of changes in fitness is a critical step in evaluating the magnitude of any demographic benefit to the natural production from supplementation. Third, understanding the mechanisms for those changes is key to developing supplementation procedures that will reduce deleterious interactions between hatchery-produced and naturally produced salmon.

Results from this project could also potentially address the 2006 critical uncertainty about population structure and diversity related to the relationship between genetic diversity and ecological and evolutionary performance given that genetic diversity and reproductive success are both examined.

Methods: This project has supported the development of many methods for determining the RRS of hatchery versus natural origin salmonids, including a new Bayesian method for assigning parentage, which appears to be superior to other procedures. Statistically reliable results have been produced and published in peer-reviewed papers. In addition, genotyping methods have been expanded to include genome-wide scans of gene loci that respond to differential rearing density and other hatchery conditions. The combination of experimental and gene scanning approaches is a potentially powerful method to determine the nature of hatchery-imposed selection.

Program Relevance and Project Results: This field and laboratory research project has demonstrated that natural spawning fitness in the Hood River is reduced in hatchery origin steelhead compared with natural origin steelhead. Experiments performed as part of this project also indicate that the observed reduction in fitness was a consequence of rapid genetic change due to hatchery conditions. The project has now shifted its focus to ascertaining why this genetic change occurred and how the effect could be ameliorated. A study of gene expression found that fry produced from hatchery origin parents expressed a suite of genes associated with responses to stress and disease differently than fry produced from natural origin crosses, a difference that is hypothetically attributed to selection pressures associated with the occurrence of pathogens, wounding, and generalized stress in the hatchery.

The project is also addressing how density-dependent selection pressure in the hatchery might affect the overall fitness of returning fish by increasing the variability in performance among families in the hatchery environment. At the same time, genomes of Hood River fish of hatchery and wild ancestry are being scanned to determine what genes respond to selection.

Other (now published) results are also worth noting here:

- Wild males appear to become resident (non-anadromous) at a higher rate than do hatchery males. Parentage analysis indicated that wild resident fish contribute substantially to endangered steelhead "populations" and highlight the need for conservation and management efforts to fully account for interconnected *Oncorhynchus mykiss* life histories.

- Inbreeding alone cannot adequately explain the 15% average fitness decline observed in first-generation hatchery fish from this population.
- Hatchery fish doubled the total number of adult fish on the spawning grounds each year, but cut the effective population size of the total population (wild and hatchery fish combined) by nearly two-thirds. This Ryman–Laikre effect was most severe when >10% of the fish allowed onto spawning grounds are from hatcheries, and the hatchery fish have high reproductive success in the wild.

The project also contributes status and trend information on Hood River steelhead and could potentially help in developing High Level Indicators associated with abundance and genetic diversity.

Reporting: Annual reporting is up to date (last report was for 2014), and detailed results are provided. Additionally, a number of primary publications have been produced to document earlier results. Overall, results from this project have been widely disseminated in a timely fashion and have had a large impact on the fishery genetics literature.

Broad Applicability: This project included a broad review of six recent studies on four salmon species to determine whether reduced fitness of early-generation hatchery fish may be a general phenomenon. Both theoretical and empirical evidence now strongly suggests that rapid adaptation to the hatchery is a sufficient explanation for the fitness declines observed in first- and second-generation fish when they spawn in the wild. Results of the study have broad applicability throughout the basin, stimulating a number of additional studies on the RRS of different species of salmonids. Additionally the comparison between gene expression in hatchery and wild progeny is likely to be repeated on other species and locations throughout the basin and may lead to some useful alterations in hatchery practices.

Time Required: It will likely take more than 5 years to determine the factors responsible for differential gene expression in hatchery and NO fish. Additional time will then be needed for experiments to determine if deleterious effects can be reduced by modifying hatchery design and operations.

200306300 - Natural Reproductive Success and Demographic Effects of Hatchery-Origin Steelhead in Abernathy Creek, Washington

Links to: project **and** reports

Proponent: US Fish and Wildlife Service (USFWS)

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Indirect or Potential:

- Fish Propagation: What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles and from harvest in fisheries targeting hatchery-origin adults?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Comment:

This project is attempting to directly address three of the 2006 critical uncertainties about fish propagation by evaluating: (1) changes in the natural spawning fitness of supplemented populations, (2) directly measuring the magnitude of any demographic benefit to the natural production from supplementation, and (3) assessing the effectiveness of conservation hatchery procedures to maintain genetic diversity and fitness of supplemented populations.

Results from the project also indirectly address, or could potentially help to address other uncertainties about fish propagation related to the cost to natural populations from interactions with hatchery origin juveniles (because the performance of hatchery and natural origin fish is compared while side-by-side in streams), and about population structure and diversity related to the relationship between genetic diversity and ecological and evolutionary performance (because genetic diversity and reproductive success are both examined).

Methods: This project evaluates the impact of supplementation and hatchery practices on maintenance of genetic diversity by comparing natural origin (NO) and hatchery origin (HO) fish side-by-side in a cohort based approach. Appropriate methods were used to test for physiological, morphological, and genetic differences in juvenile and adult HO and NO fish. Tests and protocols used to assess whether the hatchery line genetically diverged from the NO population, for example, were comprehensive and informative. Reproductive success and relative reproductive success of HO and NO fish were calculated using established procedures but sample sizes of mature fish were small.

Additionally, two adjacent streams are being used as controls in order to separate out possible environmental and annual effects on steelhead productivity from any demographic response Abernathy steelhead may be expressing due to supplementation. The challenge is not executing the lab work but the logistics of the field work, namely, to meet the sample sizes required to have sufficient data. Trends reported are based on point estimates of relevant metrics and do not include any measurement of variability associated with the estimate. Future research should focus on understanding and quantifying the sources of variability associated with point estimates of reproductive success.

Although the observed decline in reproductive success of NO individuals spawning in the presence of generally less fit HO individuals suggests a correlation, the authors acknowledge that "without information about the reproductive success of NO steelhead spawning in the absence of HO steelhead, it is impossible to assign causation due to supplementation efforts. Fitness may just as likely be declining due to poor ocean survival or other environmental variables."

The following comment from ISRP (2010) may still be relevant: "Since Germany, Mill, and Abernathy Creeks are intended to serve as reference and treatment locations respectively, the near genetic equilibrium among them, with the conclusion they have large amounts of gene flow, complicates any analysis. The challenge is twofold: First, for a demographic analysis you need a reasonable estimate of the adult progeny produced from natural spawning. If the three streams are functionally panmictic, adults attributed to one stream based on redd counts may have originated in one of the other streams. Second, if the implied large proportion of unassigned adults or juveniles is owing to adults that avoided capture at the electric weir, effort is being expended on genotyping individuals for which no useful conclusion can be reached." Perhaps related to this ISRP concern, the authors acknowledge (p. 22 of latest report): "Additionally, it is unknown if Mill Creek, Abernathy Creek and Germany Creek all function as a single population and adult fish may be preferentially returning to various streams each year. Under such hypotheses, collections of fish captured at our weir would each represent a small sample of spawners and returning offspring, and we would thus expect poor parentage assignment and low power to detect differences between HO[R] and NO[R]. Finally, if our sampling efficiency at the population level is different for HO[R] than NO[R]fish (e.g., if a weir at the hatchery release site is better at catching HO[R] fish than NO[R]fish), then estimates of relative reproductive success will be skewed. We recommend that future analyses focus on addressing these issues."

Program Relevance and Project Results: This research project is testing whether implementation of conservation hatchery practices would allow supplementation of a steelhead population without changing the genetic or ecological characteristics of that population. The natural reproductive success and mean relative fitness of HO and NO steelhead were measured to assess the demographic effects of hatchery fish supplementation in Abernathy Creek relative to two adjacent control streams.

A native hatchery brood stock of steelhead was successfully created by capturing age 0+ NO juvenile steelhead and rearing them to sexual maturity.

The conservation hatchery practices implemented here did not appear to maintain the genetic integrity of the HO population. A broad array of traits in NO and HO fish were compared at the fry, smolt, and adult stage. Some of the key differences found were, larger eggs in NO females, hatchery smolts were longer but had lower condition factors than NO smolts, age of maturity was more variable in NOs, HO smolts had lower gill ATPase levels, relative reproductive success was often found to be lower in HO fish and no large increase or decrease in NO smolt yield occurred. Substantial genetic drift occurred in spite of incorporating NO spawners into the hatchery brood line. As a result the hatchery line was less genetically diverse and differentiated from the NO population. When spawning in the creek, the reproductive success of anadromous HO fish was low relative to that of anadromous NO fish in most study years; however, small sample sizes and substantial proportions of non-sampled parents (less than 10% of returning fish were matched with both of their parents) precluded strong conclusions regarding relative reproductive success. Smolt production was neither positively nor negatively affected by the hatchery when compared to control streams. HO and NO smolts emigrated out of Abernathy with similar timing but HO juvenile fish differed physiologically and morphologically compared to NO fish and may have been less prepared to emigrate into saltwater.

In sum, this study shows that exposure to hatchery conditions had substantial negative effects on genetic diversity and scope of physiological response. These data could lead to substantially improved hatchery practices designed to minimize hatchery effects on salmonid stocks.

Reporting: Annual reporting is up to date with considerable detail and good retrospective discussion of the entire project. Earlier results have also been documented in several primary publications.

Broad Applicability: The proponents claim that the results are applicable systemwide for use in conservation hatcheries for steelhead, but this conclusion remains uncertain without a better understanding of the mechanisms for reduced relative reproductive success and decline in absolute reproductive success of HO fish. Results from this work could also be affected by the small population size of the Abernathy Creek steelhead population. For integrated hatchery populations, for example, the Hatchery Scientific Review Team has recommended a proportionate natural influence (PNI) of 0.67. The PNI of this project appears to be 0.43, likely due to low adult returns. More NO spawners need to be incorporated into the hatchery brood stock to fully examine the consequences of an integrated program. Nonetheless, the project has provided valuable results and indicated that significant genetic divergence can occur once fish are under artificial culture. Breadth of applicability will likely depend on whether similar results are obtained in studies in different circumstances.

Time Required: This study should continue for at least one to two generations to estimate responses to environmental variability and other factors that could impact the relative in-stream performance of HO vs NO fish.

200729900 - Investigation of Relative Reproductive Success of Stray Hatchery & Wild Steelhead & Influence of Hatchery Strays on Natural Productivity in Deschutes

Links to: project **and** reports

Proponent: Oregon Department of Fish and Wildlife

Province/subbasin: Columbia Plateau/Deschutes

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles or stray spawning adults and from harvest in fisheries targeting hatchery-origin adults?
- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?

Indirect or Potential:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?

Comment:

This project directly addresses two of the 2006 critical uncertainties about fish propagation. First, by measuring relative reproductive success of hatchery and natural origin steelhead spawning in the natural environment of an unsupplemented steelhead population subject to introgression with stray hatchery fish, the study affords an opportunity to assess the cost to native wild fish caused by introgression with fish straying from hatchery programs in other rivers. Second, measuring the extent of straying, and changes in fitness due to straying will help to refine supplementation procedures and policies to reduce deleterious interactions between hatchery-produced and naturally produced salmon.

Results from the project also indirectly address or could potentially help to address other uncertainties about fish propagation related to determining the carrying capacity of freshwater habitat, the effect of hatchery fish on other species (because other species are also being monitored), and the relationship between basinwide hatchery production and the survival and growth of naturally produced fish. Because PIT-tagged fish are being released, the project could also indirectly address uncertainties about the effects of hydrosystem operations on fish survival and behavior.

Methods: The ISRP (2010) concluded that "the work is well planned, using proven methods, and has been refined several times through the proposal process." Reproductive success of each parent and relative reproductive success of hatchery origin (HO) and natural origin (NO) fish will be determined by pedigree reconstruction analysis of SNP genetic data. A BACI design is being used to evaluate the possible effects of hatchery strays on the productivity of steelhead in two tributary streams of the Deschutes River. HO fish are removed at the weir at Bakeoven Creek, but allowed to spawn in Buck Hollow Creek; after five years all hatchery strays will also be excluded from Buck Hollow Creek.

The study uses mechanically marked fish, remote PIT-tag scanners, and ultimately parent-based tagging (PBT) to estimate abundances of HO and NO fish, but low recaptures preclude precise estimates in some cases. The study is collecting tissues for PBT analysis to further investigate effects of HO X NO introgression on production. The project is using standard methods to estimate adult abundance, trap efficiencies for capturing adults (steelhead and fluvial redband trout) and migrating juveniles. Smolt-to-adult survival as well as in-river survival is being estimated by applying PIT tags to juveniles as they emigrate from the study streams. Age data is being determined by scales, and life-history diversity is being deciphered via PIT tag detections, which are used to indicate residency and migration patterns in the Deschutes River and in the Columbia River out to the estuary. The presence of out-of-basin hatchery strays is being determined by several means including tags or marks and by genetic analyses that rely on the SNP panel for parent-based tagging.

Program Relevance and Project Results: This research project is designed to evaluate whether the occurrence of out-of-basin strays depresses the productivity of natural steelhead populations. It addresses an important management uncertainty in the mid-Columbia because large numbers of Snake River hatchery origin fish have been known to stray into the Deschutes River. The specific objectives are to: (1) determine the relative reproductive success of stray hatchery and wild steelhead; (2) determine the number of stray hatchery steelhead escaping into Bakeoven and Buck Hollow creeks, and (3) compare measures of fitness and productivity of the wild population and introgressed population.

The project also monitors and evaluates annual indices relevant to HSRG recommendations (e.g., PNI, pNOS, pHOS values, marking rates, and hatchery production) and describes their relevance to HGMPs.

Status and trend data are being collected for steelhead, redband trout, fluvial *O. mykiss*, and numerous non-target species of fish returning to, or emigrating from, Bakeoven and Buck Hollow Creeks.

Broad Applicability: Replication will be needed in other areas to determine whether results for the Deschutes River are typical for other populations. If so, the project would have broad applicability in the mid-Columbia and could serve as an important template for similar studies using steelhead or other salmonid species throughout the basin. The impact of introgression will likely depend greatly on the nature of adaptive differences between the native and straying populations.

Time Required: Annual reporting is up to date with considerable detail and good summaries and retrospective discussion of the entire project.

This is the fourth year of a long-term study (at least 10 years). The parentage assignments and resulting assessment of juvenile production and spawner-to-adult returns of hatchery and natural crosses of steelhead can only be completed after one generation of steelhead is allowed to return for each experimental treatment.

201003300 - Study Reproductive Success of Hatchery and Natural Origin Steelhead in the Methow

Links to: project **and** reports

Proponent: Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Columbia Cascade/Methow

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?

Indirect or Potential:

- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Comment:

This project directly addresses several of the 2006 critical uncertainties about fish propagation as it is specifically designed to measure relative reproductive success of hatchery and natural origin steelhead spawning in the natural environment. First, the project is evaluating changes in the natural spawning fitness of supplemented populations, as well as examining possible reasons for such changes. Second, measuring the extent of changes in fitness is a critical step in evaluating the magnitude of any demographic benefit to natural production from supplementation. Third, understanding the mechanisms for those changes is important when developing supplementation procedures that will reduce deleterious interactions between hatchery-produced and naturally produced salmon.

Results from this project could also potentially address the 2006 critical uncertainty about population structure and diversity related to the relationship between genetic diversity and ecological and evolutionary performance given that genetic diversity and reproductive success are both examined.

Methods: Methods and statistical analyses seem appropriate for comparing a suite of traits in adult hatchery origin (HO) and natural origin (NO) steelhead returning to the Twisp River. Data are examined for normality and transformed as necessary to meet the requirements of parametric tests, or when such transformations fail, non-parametric methods are being used. DNA-based pedigree analyses are currently underway. The ISRP (2010) review expressed the concern that "… likelihood of substantial past crossing of wild and hatchery fish will complicate using a difference in relative reproductive success between the hatchery- and natural-origin steelhead as a valid basis for drawing biological conclusions and useful management implications."

Program Relevance and Project Results: The goals of this project are to: (1) directly measure the relative reproductive success of hatchery origin (HO) and natural origin (NO) steelhead in the natural environment using a DNA pedigree approach; (2) determine the degree to which any differences in reproductive success between hatchery and wild steelhead can be explained by measurable biological characteristics such as run timing, morphology, spawn timing, age composition, length-at-age, sex ratio, fat content, fecundity, egg weight or spawning location; and (3) estimate the relative fitness of hatchery-lineage steelhead after they have experienced an entire generation in the natural environment. Funding for pedigree determination was put on hold, but preliminary results on marked fish show some interesting trends.

Results to date suggest few, and small, differences between NO and HO fish (in fecundity, fork length, and fat content) but results are preliminary and unpublished.

Trends in HO and NO steelhead abundance are also being documented.

Reporting: Annual reporting is up to date with adequate detail and some retrospective discussion of the entire project.

Broad Applicability: This project is similar and complementary to other studies of relative reproductive success within the Columbia Basin. The genetic makeup of NO steelhead in the Twisp River is likely a homogenization of many up-river natural and hatchery stocks. Thus, the baseline for reproductive success of NO spawners may have already been shifted by past impacts of hatchery fish. However, this situation is probably common elsewhere in the Basin too.

Time Required: Results are being reported in a timely fashion, but this project will need to be conducted for at least another seven years to accomplish all its objectives (i.e., to investigate six brood years experiencing natural conditions for a full generation). Additional time may be needed depending upon the annual variability in adult abundance and observed reproductive success.

Hatchery Culture Practices and Reform

199305600	Advance Hatchery Reform Research	National Oceanic and Atmospheric Administration
200900900	Basinwide Supplementation Evaluation	Columbia River Inter-Tribal Fish Commission (CRITFC)
200203100	Growth Modulation in Salmon Supplementation	National Oceanic and Atmospheric Administration, University of Washington

Summary

The three projects listed above focus on hatchery culture practices and reforms and have generally investigated similar questions. In some instances comparable approaches were used to address an uncertainty, whereas on other occasions, different approaches were employed or diverse aspects of the same problem were examined. For instance, the development of precocious male parr in hatchery populations of spring Chinook and steelhead is a prevalent problem in many Columbia River Basin hatchery populations. In the Basinwide Supplementation Project (#2009-009-00) controlled crosses are being used to determine if paternal age influences the occurrence of early maturation. Alternatively, the Growth Modulation Project (#2002-031-00) is examining the effects of diet, emergence timing, and broodstock origin on early male maturation. Spring Chinook are used in both investigations. Early maturation and freshwater residualism in steelhead is being examined by the Hatchery Reform Research Project (#1993-056-00). In this case, the effects of a one-year or two-year rearing period are being evaluated. Not only for early maturation but also on a suite of other attributes, e.g. juvenile foraging behavior, size at release, variation in size at release, smoltification status at release, migration rate, and age at maturation. Residualism and precocious maturation are important problems in salmonid culture. Residual hatchery fish may compete for food and space with natural origin conspecifics, prey on native juvenile fishes and interbreed with natural origin adults. Consequently, these studies, which are designed to assess the importance of genetic and environmental factors leading to early maturation, should help determine how their abundance can be reduced.

Two of the projects are comparing the relative reproductive success (RRS) of hatchery and natural origin adults. Similar genetic methods are being used, but several significant differences exist. The Basinwide Supplementation Project is examining RRS in two spring Chinook populations. In both situations, hatchery adults have been produced exclusively by natural origin adults. Similarly RRS in steelhead is being investigated in the Hatchery Reform Research Project in which reproductive success will be compared among three types of adults, those produced by one- and two-year old hatchery smolts and by naturally produced individuals. Unlike the spring Chinook investigations, hatchery origin steelhead adults were produced by both hatchery and natural origin parents. Additionally, the natural origin steelhead parents likely have some hatchery origin ancestry due to past extensive hatchery plantings. Because all the fish being compared in the steelhead study have either been exposed to hatchery conditions or have ancestors that were produced by artificial propagation, any performance differences in RRS due mainly to genetic changes caused by inadvertent domestication may be difficult to detect. On the other hand, if large differences are observed, this would suggest that environmental factors rather than genetic changes are largely responsible

Along with these general commonalities, the projects are also investigating different issues. The current goal of the Hatchery Reform Research Project is to determine whether local steelhead broodstocks can be produced by rearing two-year old smolts in upper Columbia River Basin hatcheries. The Basinwide Supplementation Project is using genetic tools to evaluate how best to reintroduce anadromous salmonids to portions of the Columbia Basin from which salmonids have been extirpated in the past by dams or other constraints. And as previously mentioned, the Growth Modulation study, is examining how diet and other factors can be modified to reduce precocious maturation and residualism. Although not mentioned in the annual reports, the data and genetic samples being collected from the Basinwide Supplementation and Hatchery Reform projects could be used to address another important uncertainty, the effects of genetic diversity on fitness and population resilience.

199305600 - Advance Hatchery Reform Research

Links to: project **and** reports

Proponent: National Oceanic and Atmospheric Administration

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?

Indirect or Potential

- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- The project is addressing several new uncertainties. First, is the high growth rate experienced by 1-yr-old hatchery steelhead smolts contributing to maladaptive behavioral traits or physiological deficits that lead to reduced post-release survival and genetic fitness?
- Second, can hatchery reforms be instituted to develop local steelhead broodstocks that can be released as 2-yr-old smolts and meet expected conservation and harvest objectives?

Comment:

Portions of the four uncertainties listed above are being examined by the project:

Uncertainty #1 above was tangentially examined: The project is attempting to transition to a local broodstock. In order to accomplish that, juveniles will need to be reared for two years (S2) due to adult spawning dates and cool water temperatures at the hatchery. Hence studies were undertaken to examine rates of precocious maturation and residualism in the two rearing treatments that might increase the likelihood of interactions between natural origin juveniles and S2 smolts than between natural juveniles and S1 (1-yr-old) hatchery smolts. The project does not examine how spatial or temporal partitioning of hatchery and wild fish might reduce interactions between hatchery and wild steelhead.

Uncertainty #2 may be partially examined in the future. The relative reproductive success of adults produced from S1, and S2 smolts will be examined during 2015-2017. The proponents state that determining the appropriate percentage of hatchery origin fish on spawning grounds (pHOS) and the effects of the hatchery program on viable salmonid population (VSP) parameters depends on the relative reproductive success of hatchery fish. That is currently unknown for S2 adults and will be a future emphasis for the project.

Uncertainty #3 is being addressed in part. The project is evaluating whether it is possible to establish a local steelhead broodstock and rear 2-yr-old steelhead in an effort to maintain genetic diversity in the Methow subbasin. If the approach proves to be viable it could be exported to other subbasins in the Columbia and used to maintain meta-populations of steelhead in those watersheds.

Uncertainty #4 is being indirectly addressed by the project. Adult steelhead from the Wells and Winthrop hatcheries have been genotyped for 15 microsatellites. As the project continues it may be possible to link the genetic information from this project with genetic data from other steelhead populations to examine how genetic diversity influences the fitness and resilience of steelhead populations.

Methods: Appropriate experimental designs and innovative behavioral and physiological assays were used by the project. Statistical analyses were well described and comprehensive; p-values, means, along with standard deviations were reported.

Program Relevance and Project Results: From 2006 to 2010, this project had three objectives: (1) maintain adaptive life history characteristics in Chinook salmon, (2) improve imprinting in juvenile sockeye salmon, and (3) match phenotypes in hatchery origin Chinook and sockeye salmon to those present in natural-origin fish per Reasonable and Prudent Alternative (RPA 63.2). Since 2010 the project has investigated whether it is possible to establish local steelhead broodstocks and rear and release 2-yr-old smolts, which is the age at migration for most natural origin smolts. Behavioral and physiological comparisons between steelhead smolts originating from a common broodstock but reared for one (S1) or two years (S2) are being conducted. Although the project is ongoing, some preliminary results have shown that S2 smolts are more uniform, larger, and consistent in their smolt development than S1 fish. Additionally, S2's achieved higher in-river survivals and faster out-migration rates. Of particular concern was what effect the rearing regimes might have on the development of precocious parr or the initiation of early maturity. Hatchery-induced residualism caused by early male maturity would make it nearly impossible to implement hatchery reform alternatives because controlling Proportionate Natural Influence (PNI) and other important parameters would be problematic if residuals are maturing and interbreeding with natural-origin fish. Greater than 90% of the males in both treatments smolted, and no difference in overall early maturation rates appears to exist between the two rearing regimes. Laboratory assessments were also performed including extended seawater rearing that examined the effect of the two freshwater rearing regimes on age-at-maturity. The S2 regime produced females that mature almost exclusively as 4-yr-old fish. The S1 regime produced females that matured as 3- and 4-yr-old fish. The S2 regime caused a higher proportion of males to mature after one year of sea life when compared to SI males. But most males matured after two years of salt water growth.

No status and trend data were reported but the abundance of S1 and S2 adults produced by the project will be tracked.

Broad Applicability: Results from this project have the potential to significantly increase the use of local steelhead broodstocks and alter how steelhead are cultured in the future throughout the Basin, but particularly in the upper Columbia River.

Time Required: Results are being reported in a timely fashion. The first adult returns from the experiment are expected to arrive in 2015, and a RRS study using adults produced from S1 and S2 smolts is planned. Consequently more than five years will be needed to complete the project.

200900900 - Basinwide Supplementation Evaluation

Links to: project **and** reports

Proponent: Columbia River Inter-Tribal Fish Commission (CRITFC)

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?

Indirect or Potential:

- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Comment:

Uncertainty #1 is directly examined by the project since it is helping research partners to determine the relative reproductive success (RRS) of spring Chinook spawning in Johnson Creek and in the upper Yakima River. Management rules are in place in both of these situations, and it may be possible to use historical data to help understand how pHOS values (proportion of natural spawners composed of hatchery origin fish), natural origin recruits (NO) broodstock mining rates, and pNOB (proportion of hatchery broodstock composed of NOs) have influenced the spawning fitness of natural spring Chinook returning to Johnson Creek and the upper Yakima River.

Uncertainty #2 is also being directly examined. Demographic data being collected in the upper Yakima and in Johnson Creek on spring Chinook and will provide information on the potential benefits of supplementation on the production of NOR juveniles and adults.

Uncertainty #3 is largely addressed as data obtained from the RRS studies and reintroduction projects will help deal with this uncertainty.

Regarding Uncertainty #4, genetic data obtained from the reintroduction projects as well as the RRS studies could potentially be used to examine the relationships between genetic diversity and ecological/evolutionary performance. However, at present the project is not formally addressing these relationships

Methods: The objectives and methods employed by the project are similar to other studies that seek to understand the relative reproductive success (RRS) of hatchery origin (HO) and natural origin (NO) salmonids spawning in nature. RRS was estimated by carrying out pedigree analyses on tissue samples collected on adults and juveniles by research partners performing studies in the mid-Columbia and Snake River basins. Results of these analyses, which rely on genetic variation in microsatellites and SNP panels, were summarized but statistical details were not provided. Dual-Frequency Identification Sonar (DIDSON) was used to estimate natural escapement of spring Chinook salmon into newly opened habitat in the Klickitat River but results from this effort were not yet available. The geographic scope of this project is large and is meant to synthesize and draw together basinwide results on RRS studies and on the success of salmonid reintroductions presumably by adaptation of HO lineages to novel environmental conditions. The project is using high-throughput genotyping methods (i.e., SNPs) to unify datasets and provide efficient genotyping.

Program Relevance and Project Results: The primary focus of the project is to assess critical uncertainties related to effects of hatchery supplementation on productivity of depressed natural salmon populations. It is also assessing programs that are attempting to establish new natural populations by stocking out-of-basin hatchery- or natural-origin fish into subbasins where indigenous populations have been extirpated. The emphasis on uncertainties related to genetic adaptation during reintroduction and on testing techniques for reintroduction are important new critical uncertainties.

Consequently, the project addresses hypotheses and questions that are relevant to management decisions. For example, genetic analyses are being conducted in two streams to ascertain the RRS of hatchery-origin spring Chinook. One is taking place in Johnson Creek, a Salmon River (Snake River Basin) tributary and another was just started on the upper Yakima River (Mid-Columbia). In both cases, HO adults are produced from hatchery broodstock that consist of 100% NO fish. In the Johnson Creek study, genetic analyses on five broodyears have been completed. Results indicate that the proportion of fish identified as parents of one or more adult offspring were similar in HO and NO females. HO males and jacks, however, were less successful than NO counterparts. The project is also engaged in genetic analyses that are examining whether hatchery-origin fish reintroduced into habitat where natural origin fish have been extirpated are adapting to their new habitats. Three of these investigations on spring Chinook are occurring, one in Hood River (Deschutes Subbasin), another in Lookingglass Creek (Grande Ronde Subbasin), and one in Newsome Creek (Clearwater Subbasin). In the Hood River, NO adults produced from hatchery fish appear to have higher productivity than HO adults. The analyses also indicated that Chinook from the lower Columbia and Willamette River were naturally re-colonizing the Hood River and that these natural colonizers were more productive than the NO recruits produced from the planted hatchery fish which were from interior Columbia River Chinook stocks.

Two other studies investigated management questions surrounding sockeye reintroduction efforts. In one instance, the Yakama Nation has been introducing sockeye adults captured at Priest Rapids Dam into Cle Elum Lake. This effort began in 2009. The introduced sockeye originate from two stocks, Wenatchee and Okanogan. Genetic analyses on tissue samples collected on sockeye spawning in the Cle Elum Lake basin and on juveniles emigrating from the Yakima River showed that Wenatchee and Okanogan sockeye spawned in different areas and at different times. Additionally, most of the juveniles produced originated from Wenatchee origin adults even though 75% of the transplanted adults were from the Okanogan stock. In the other study the stock origins of kokanee and anadromous sockeye spawning in the Deschutes River subbasin were investigated. The project has also just started a study at the Cle Elum Supplementation Research Facility that is using genetic parentage analyses to investigate the effects of parental age on the occurrence of minijacks in hatchery reared spring Chinook.

Status and trend data are being collected in many of the studies that the project is participating in, e.g. the spring Chinook studies taking place at Johnson Creek, the Upper Yakima River, at Hood River, and at Lookingglass and Newsome Creeks. Sockeye status and trends are being assessed by research partners in the Yakima and Deschutes River subbasins. The project itself does not collect status and trends data, but its genetic analyses make these data available.

High Level Indicators touched on by the project are abundance and genetic diversity.

Broad Applicability: This program has potentially broad relevance as a clearinghouse for genotypic data on salmonids in the Columbia Basin and as a forum for unifying actions regarding hatchery operations. Its effectiveness will depend on provision of a database, adoption of new genetic monitoring approaches, and demonstrable coordination between entities.

Time Required: This project has a 10-year time frame. Significant progress should be made on providing basinwide genotype data, conversion to SNP genotyping, and coordination of entities over the next few years.

200203100 - Growth Modulation in Salmon Supplementation

Links to: project **and** reports

Proponent: National Oceanic and Atmospheric Administration, University of Washington

Province/subbasin: Columbia Plateau/Yakima

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?

Indirect or Potential:

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?

Additional Uncertainties Addressed or Raised (not in 2006 Research Plan):

- Fish Propagation: Does an integrated hatchery approach lead to greater production of mini-jacks?
- Fish Propagation: How can hatchery practices be modified to improve survival, age at maturation, and contributions to fisheries?

Comment:

This is a highly relevant and practical research project that addresses key uncertainties involving survival and maturation rates of hatchery Chinook salmon and the potential effects of hatchery supplementation on natural production and hatchery production. Results from this project may be used to help develop hatchery rearing regimes for various stocks that minimize early male maturation rates and improve hatchery smolt-to-adult survival rates (SARs) while minimizing negative impacts to protected natural stocks, including resident fishes.

The first uncertainty listed above is directly addressed by developing hatchery approaches that reduce early maturation of Chinook salmon, including mini-jacks and their interactions with natural salmon.

New uncertainty: the project is directly addressing an emerging critical uncertainty regarding the effect of the integrated hatchery approach on minijack production. Evidence suggests that the integrated hatchery approach may lead to increased production of minijacks, which is counter-productive. The Yakima River Project is also addressing minijack production effects (Project 199506325).

New uncertainty: the project also provides information on methods to improve survival (and age at maturation) of hatchery salmon. A reduction in minijack production could greatly increase the number of hatchery smolts entering the ocean. Survival of these growth-modified fish needs to be monitored and evaluated.

The project contributes indirectly to the other three fish propagation uncertainties listed above.

Methods: Methods and analyses are appropriate.

Program relevance and brief summary of findings: This project directly supports the F&W hatchery program RM&E strategy to "Evaluate the effectiveness of hatchery safety-net/conservation programs and the effectiveness of hatchery reform actions on the achievement of biological performance objectives" by directly monitoring hatcheries and hatchery reform projects at production facilities throughout the Columbia Basin (Study Objective 1) and "Assess and investigate as appropriate critical uncertainties regarding the effects of artificial propagation on the viability of wild fish populations" by conducting controlled production and laboratory scale experiments (Study Objective 2 and 3).

An essential requirement of supplementation programs is to minimize alteration of the genetic and phenotypic characteristics of the supplemented natural population since these fish are often listed as threatened or endangered under the Federal Endangered Species Act. Results from this project may be used to help develop hatchery rearing regimes that minimize early male maturation rates and improve SAR's while minimizing negative impacts to protected natural stocks.

Significant contributions from the study to date include:

1) Documentation that hatchery practices promote early male maturation and that hundreds of thousands of early maturing males (age-2 minijacks) are released from production and conservation hatchery programs throughout the Columbia and Snake River basin each year. Minijacks are not smolts when released, and they do not contribute to harvests.

2) A reduced (experimental) feeding regime (Low Fat/Low ration) produced lower micro-jacking and minijacking rates than the standard feeding regime (High Fat/Full ration). The standard regime may have produced the biggest smolts, but the Low Fat/Reduced Ration may have produced the more optimally developed "smolt."

3) Early emergence resulted in high minijack rates (~60% of males) independent of ration. Middle emergence results in high minijack rates as well, but can be modulated by reduced ration. Late emerging fish show high minijack rates too, but lower rations can reduce these rates by 67% (from 57% down to 19%).

4) A common-garden experiment is currently underway to test how the source of broodstock affects early maturation. Evidence to date suggests that artificial selection against early maturation in segregated hatcheries has acted to reduce the effect of hatchery rearing on early maturation relative to that in integrated hatcheries. This may have important consequences for the integrated hatchery approach.

Overall, these results are being used to develop feeding and rearing guidelines for hatcheries to avoid unnaturally high rates of early male maturation. In particular, they will help hatchery managers to understand how much variation in spawn timing and ponding date is needed to optimize production of either under-yearling or yearling smolts. This is important because many hatcheries in the Snake River Basin do not think they are producing many minijacks (see ISRP Snake River Compensation Plan review). A reduction in minijack rates could lead to increased adult returns (and harvests) if survival at sea of the growth-modified fish is not significantly reduced.

Broad Applicability: The results of this study have broad applicability as the proponents are investigating both the ultimate and proximate evolutionary explanations for early maturation in salmonids. Many Chinook hatcheries in the Columbia Basin produce numerous minijacks that ultimately reduce survival to the large adult stage and may lead to undesirable interbreeding with Chinook salmon on the spawning grounds.

Time Required: The project has developed timely reports and publications. Final results are expected within five years or so when all adults from the experiments have returned.

Chum

200871000 - Development of an Integrated Strategy for Chum Salmon Restoration in the Tributaries below Bonneville Dam

Links to: project **and** reports

Proponent: Washington Department of Fish and Wildlife (WDFW)

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Habitat Estuary, Plume and Ocean: What specific factors affect survival and migration of species and life-history types of fish through the estuary, and how is the timing of ocean entry related to subsequent survival?
- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Recolonization: Does the straying rate of chum salmon limit the natural rate of recolonization of streams from which they were extirpated?

Comment:

This hatchery/spawning channel and monitoring project directly addresses a new uncertainty related to the rate at which ESA-listed chum salmon can naturally recolonize streams in the Lower Columbia from which they were extirpated. It also indirectly addresses two 2006 uncertainties about fish propagation related to the magnitude of demographic benefits in natural production from supplementation and the estimation of carrying capacity of spawning areas.

Past activities within the project (baseline surveys of variation in microsatellite DNA) provided data on population structure and diversity that could help to address the 2006 critical uncertainty about the relationship between genetic diversity and ecological and evolutionary performance.

The project could also potentially address other uncertainties related to harvest and survival rates in the estuary because all juveniles produced in the hatchery are thermally marked.

Methods: Seem generally appropriate but difficult to evaluate here because methods and results are described piecemeal in numerous small reports.

Program Relevance and Project Results: WDFW's recovery strategy for Lower Columbia River (LCR) chum salmon, as outlined in the WDFW Grays River and Washougal Hatchery Genetic Management Plans (HGMP), is as follows: First, determine if remnant populations of chum salmon exist in LCR tributaries. Second, if such populations exist, develop stock-specific recovery plans involving habitat restoration that include the creation of spawning refuges, supplementation where necessary, and a habitat and fish monitoring and evaluation plan. If chum salmon have been extirpated from previously utilized streams, develop reintroduction plans using appropriate genetic donor stock(s) of LCR chum salmon, and integrate habitat improvement and fry-to-adult survival evaluations.

The Duncan Creek Project has two goals: (1) reintroduction of chum salmon into Duncan Creek by providing off-channel high-quality spawning and incubation areas, and (2) to simultaneously evaluate natural recolonization, direct adult supplementation and hatchery fed-fry supplementation.

Two methods of reintroduction are being simultaneously evaluated at Duncan Creek. The first is direct-adult supplementation: adult chum salmon are collected from Lower Gorge populations and released into the Duncan Creek spawning channel and allowed to naturally reproduce. The other supplementation strategy requires adults to be collected and artificially spawned, eggs incubated, fry reared, and fed-fry released at the mouth of Duncan Creek.

The goal of the chum salmon enhancement program at Grays River Hatchery is to preserve genetic diversity within the Columbia River Coastal population and provide a source of chum salmon for reintroduction into other potential spawning sites in the Columbia River Coastal zone. This is accomplished by collecting sufficient numbers of broodstock to maintain genetic diversity and by collecting those adults over the entire run period.

Reporting: Annual reports are up to date and contain considerable detail, but they are not well summarized. Moreover, the overall project is difficult to understand and review because none of the reports provide a retrospective synthesis of achievements to date. For example, the latest annual report states: "A complete analysis including stray rates and project-origin adult contributions to spawning populations outside the Grays River Basin will be completed, but is outside the scope and intent of this progress report." An exception is the thorough analysis and reporting of results from initial surveys of genetic variation among chum populations.

Broad Applicability: Results from this project apply generally to chum salmon in the Lower Columbia River (and other coastal rivers) but are not likely to be applicable elsewhere in the Columbia basin.

Time Required: This project was to continue for 12 years when it was proposed (in 2006). The ISRP (2006) recommended that results be reviewed at mid-term. One of the main activities within this project (Duncan Creek spawning channel) had already begun operation in 2001.

Sockeye

200740200	Snake River Sockeye Captive Propagation	Idaho Department of Fish and Game (IDFG)
201007600	Characterizing migration and survival for juvenile Snake River sockeye salmon between the upper Salmon River basin and Lower Granite Dam	Idaho Department of Fish and Game (IDFG)
200830700	Deschutes River Sockeye Development	Confederated Tribes of Warm Springs
200850300	Studies into Factors Limiting the Abundance of Okanagan and Wenatchee Sockeye Salmon	Columbia River Inter-Tribal Fish Commission (CRITFC)

AFEP Sockeye Study[7]

AFEP 2014-08	Passage and Survival of Adult Snake River Sockeye Salmon within and Upstream from the Federal Columbia River Power System	Adult Salmon and Steelhead Studies

200740200 - Snake River Sockeye Captive Propagation

Links to: project **and** reports

Proponent: Idaho Department of Fish and Game (IDFG)

Province/subbasin: Mountain Snake/Salmon

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

[7] AFEP 2014-08 refers to a presentation from the 2014 Annual Research Conference for the U.S. Army Corps of Engineers' Anadromous Fish Evaluation Program. This overview provides a snapshot of AFEP efforts and is *not* intended to be a comprehensive analysis of AFEP.

Indirect or Potential:

- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Comment:

This hatchery and monitoring project directly addresses three of the 2006 critical uncertainties related to fish propagation. The project is assessing the magnitude of demographic benefits of supplementation to natural production by enumerating and identifying the origin (hatchery or natural) of out-migrating smolts and returning adults. In addition, the project is monitoring ecological interactions between hatchery origin sockeye and natural origin kokanee in several high elevation lakes, and estimating the carrying capacity of these lakes for sockeye.

The project indirectly, or potentially, addresses other 2006 uncertainties related to harvest and hydrosystem impacts on survival (juvenile releases are PIT-tagged, and SARs are evaluated), and population structure and diversity (genetic diversity and the spatial and temporal distribution of natural spawners, both anadromous and non-anadromous are being monitored).

Methods: Seem appropriate and include genetic spawning plans to maintain diversity based on microsatellite DNA, rigorous standards for fish culture and disease testing, and release of PIT-tagged juveniles to several (replicate) lakes where physical and biological parameters are monitored. Sockeye smolts out-migrating from Redfish Lake are monitored at a weir located on Redfish Lake Creek, and weirs are used to collect returning anadromous adults.

Program Relevance and Project Results: This project is part of an interagency effort to prevent the extinction of the Redfish Lake stock of Snake River sockeye salmon. IDFG acts as the lead agency for the project and maintains the primary broodstock facility in Eagle, Idaho and provides fish monitoring and evaluation support (Project no. 1991-072-00). Fish culture responsibilities are shared by NOAA Fisheries (Project no. 1992-040-00) and ODFW (Project no. 2005-012-00). The Shoshone-Bannock Tribes provide habitat support for the project and also share fish monitoring and evaluation responsibility for the program (Project no. 1991-071-00).

The ISRP (2007) noted that: “The Snake River sockeye captive culture program has been successful in rearing sockeye salmon in closed culture. The current SARs appear to be sufficient to transition from a captive to a ‘conventional’ anadromous culture program. The current SARs appear to still be too small to plan for development of an integrated program, which requires a natural population at or above replacement.”

The status of Snake River sockeye has continued to improve since that ISRP review, making this project a (rare) compelling example of how captive breeding and intensive supplementation can be used to rescue a natural population.

Reporting: Annual reports are detailed and up to date but do not provide a retrospective synthesis of the whole project.

Broad Applicability: Results from this project apply primarily to sockeye salmon in the Stanley Basin, but lessons learned about captive breeding and restoration there would likely be useful elsewhere.

Time Required: This long-term project began in the 1990s and continued monitoring is proposed for the foreseeable future (>5 years).

201007600 - Characterizing migration and survival for juvenile Snake River sockeye salmon between the upper Salmon River basin and Lower Granite Dam

Links to: project **and** reports

Proponent: Idaho Department of Fish and Game (IDFG)

Province/subbasin: Upper Snake/Snake Headwaters

2006 Research Plan uncertainties addressed:

Direct:

- Mainstem Hydrosystem Flow and Passage Operations: What are the optimal temperature and water quality regimes for fish survival in tributary and mainstem reaches affected by dams, and are there options for hydrosystem operations that would enable these optimal water quality characteristics to be achieved? What would be the effects of such changes in operations and environment on fish, shoreline and riparian habitat, and wildlife?

Indirect or Potential:

- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?

Comment:

This project directly monitors survival of fish from the rearing ground to the first dams in the hydrosystem to identify sources of mortality. Effects of habitat and water quality measurements may be identifiable from these studies.

Methods: Juvenile sockeye salmon from Sawtooth (25,000 fish) and Oxbow (10,000 fish) fish hatcheries were PIT-tagged. An additional 400 fish from each hatchery had radio-tags implanted. PIT-tagged fish were detected on dams on Snake and Columbia rivers. A total of 41 fixed-site telemetry receivers at 21 locations were used to track the radio-tagged fish.

Program Relevance and Project Results: Determining where and why mortality occurs is a critical element in the success of recovering the endangered Snake River sockeye salmon. PIT tags and radio telemetry were used to determine travel time and the magnitude and locations of mortality. The ISRP (2010) concluded that this project should be ranked as high priority.

In 2013 (latest report), radio-tagged fish had lower survival rates than PIT-tagged fish, but this may be an artifact of surgery.

Survival of PIT-tagged fish released at Redfish Lake in 2013 was 51-59%. Fish released from Sawtooth hatchery had higher survival rates (0.10 higher) than those released from Oxbow hatchery, but this appears to be due to differential survival mostly just below outlet of Little Redfish Lake.

Median travel time through the 750-km study reach ranged from 6.3 to 7.4 d. Travel time to Lower Granite Dam of Sawtooth hatchery PIT-tagged fish is longer than Oxbow releases (radio- and PIT-tagged) and Sawtooth releases (radio-tagged).

Migration rates for radio- and PIT-tagged sockeye salmon groups were similar through all study reaches and increased as they continued downstream until reaching the section of the Snake River influenced by the hydropower system. Four reaches in particular were associated with reduced survival, and three of these reaches were associated with lower migration speeds that likely increased vulnerability to predation.

Now that 2014 data are available, a synthesis report is being prepared to examine environmental factors that might help to explain variation in survival rates.

Broad Applicability: The project provides insights about migration speed and survival that are specific to sockeye salmon in the Salmon River. However, the methods being used are broadly applicable.

Time Required: This project was to be conducted for four years (2011 through 2014) to capture the effects of annual variability between environmental conditions and brood years. Presumably the project is now complete pending final synthesis report.

200830700 - Deschutes River Sockeye Development

Links to: project **and** reports

Proponent: Confederated Tribes of Warm Springs

Province/subbasin: Columbia Plateau/Deschutes

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?

Comment:

This project addresses uncertainties related to the goal of using resident kokanee populations to re-establish an anadromous sockeye salmon run to the Deschutes River Basin. The project also directly addresses uncertainties about how tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations.

Because smolts are being tagged and enumerated, results from the project could potentially help to address uncertainties related to the effects of hydrosystem operations on fish survival and behavior.

Methods: Monitoring methods seem standard and appropriate, and include operation of a rotary screw trap at the outlet of Suttle Lake to capture anadromous smolts; spawner surveys to estimate the escapement from Lake Billy Chinook into the Metolius River; mobile hydroacoustic surveys estimate of summer and winter limnetic fish population size in Lake Billy Chinook; and collection of genetic tissue to identify genetic lineage of populations in Lake Billy Chinook and Suttle Lake. The proposal was reviewed and approved in part by the ISRP (2012). The ISRP had some concerns about the adequacy of sample sizes and hence precision of estimates that could be produced. It’s not clear whether these concerns have been resolved.

Program Relevance and Project Results: Anadromous sockeye runs to Suttle Lake were extirpated by construction of Pelton Round Butte hydroelectric dam complex in the 1960s, but resident kokanee populations now exist in the reservoirs (e.g., Lake Billy Chinook) created by the dams. There remains some uncertainty about the genetic origin of these kokanee populations (land-locked vestiges of the original sockeye run versus non-native kokanee persisting after transplants). This project has focused primarily on monitoring kokanee abundance in the reservoirs, facilitating and estimating the outmigration of sea-run kokanee “smolts” and monitoring and examining returning adults. Specific objectives include: (1) investigate timing and relative abundance of smolts out-migrating from Suttle Lake; (2) use PIT tags to identify potential bottlenecks segregating the Suttle Lake and Lake Billy Chinook populations; (3) estimate the abundance of spawning adults migrating into the Metolius River from Lake Billy Chinook; (4) estimate the wintertime and summertime population of limnetic fishes in Lake Billy Chinook; and (5) collect genetic tissue samples from multiple locations and life stages to assess the genetic lineage of *O. nerka* in both Suttle Lake and Lake Billy Chinook (note linkage to project 2009-009-00).

Adult sockeye known to have originated from upstream of Pelton Round Butte have returned (19 in 2011, 86 in 2012, and 25 in 2013). However, none of 729 PIT-tagged smolts released in 2009 survived to return.

Annual reporting is up to date (last report was for 2014) and provides detailed information about activities and results from recent years.

Broad Applicability: Results from this project apply mainly to the Deschutes subbasin. Of course, any success in restoring anadromous runs from kokanee in the Deschutes subbasin would provide an incentive for similar efforts elsewhere.

Time Required: Monitoring began in 2009. Additional years of investigation are needed to evaluate whether the population can grow and potentially support harvest.

200850300 - Studies into Factors Limiting the Abundance of Okanagan and Wenatchee Sockeye Salmon

Links to: project **and** reports

Proponent: Columbia River Inter-Tribal Fish Commission (CRITFC)

Province/subbasin: Columbia Cascade/Entiat, Columbia Cascade/Methow, Columbia Cascade/Okanogan, Columbia Cascade/Wenatchee

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or

populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?

- Mainstem Hydrosystem Flow and Passage Operations: What are the optimal temperature and water quality regimes for fish survival in tributary and mainstem reaches affected by dams, and are there options for hydrosystem operations that would enable these optimal water quality characteristics to be achieved? What would be the effects of such changes in operations and environment on fish, shoreline and riparian habitat, and wildlife?

Indirect or Potential:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?

Comment:

This project directly addresses several 2006 critical uncertainties related to the survival and production of Okanogan and Wenatchee sockeye salmon populations. It is investigating juvenile and adult migration through mainstem and tributary habitats to assess the impact of factors affected by dam and fish trap operations (primarily the effects of temperature and flow), and the magnitude of fishery interceptions.

Results from the project could potentially help to address additional uncertainties related to the effects of hydrosystem operations on fish passage, and the current carrying capacities of Wenatchee and Osoyoos lakes relative to historical conditions.

Methods: Appropriate. Adult sockeye were tracked with PIT tags applied at Bonneville Dam and with acoustic tags applied at Wells Dam to detection points along the mainstem Columbia and in the Okanagan River. GSI methods were used to estimate stock composition of tagged fish that could not be tracked to a destination point. Sockeye smolts were tracked with JSATS tags from Skaha and Osoyoos lakes down the Okanagan River to its confluence with the Columbia. Acoustic trawling was also conducted in Wenatchee Lake to provide estimates of survival from spawning to the pre-smolt stage, comparable with those available for Osoyoos and Skaha lakes.

Program Relevance and Project Results: This project investigates factors limiting the survival and production of Okanogan and Wenatchee sockeye salmon populations. The project has focused primarily on adult migration from Bonneville Dam to spawning areas upstream, to identify reaches and factors associated with high mortality. The project also provides estimates of stock composition of adult returns at Bonneville Dam and some stock-specific mainstem harvest data, as part of the attempt to account for all sockeye passing BON dam.

Production from the Okanogan population currently appears to be limited by mortality upstream of Wells Dam. In recent years, the study has expanded to monitor the survival of tagged smolts migrating down the Okanagan River and the abundance of pre-smolts in Lake Wenatchee.

Lake Wenatchee sockeye production has not increased in recent years as much as Okanagan sockeye, or even Snake River sockeye. Obtaining comparable estimates of pre-smolt abundance in Lake Wenatchee (this project) and Skaha and Osyoos lakes (Canadian project) will allow estimates of “freshwater” and “marine” survival to be partitioned and compared among cases to elucidate limiting factors.

Another unanswered question is how current production for both Osoyoos and Wenatchee sockeye salmon compares to historical production; a run of 0.5 million sockeye in 2012 with <5% habitat available suggests to investigators that historical abundance estimates may be conservative; paleolimnological work may address this issue. From 2008 and 2010, this study documented delays in passage at Tumwater Dam on the Wenatchee River that was likely attributable to 24 hour operation of the trap at that facility. Of the entire estimated run of 517,154 in 2012, 41.8% could not be accounted for, 32.6% were harvested, and only 25.6% were estimated as escapement.

Reporting: The last annual report available on Pisces was for 2012. The annual reports provide details about activities and results for the year in question, but do not include much discussion or integration of results from previous years. More synthesis and retrospective discussion would be useful.

Broad Applicability: Results from this project apply primarily to sockeye populations migrating in the Upper Columbia River, which account for the vast majority of sockeye returning to the basin. Juvenile and adult sockeye survival through the hydrosystem could be compared with that of other species.

Time Required: Monitoring began in 2009 and appears to be funded through 2017. Many questions will be addressed within this period but continued monitoring to establish time series for future assessments would be useful.

Kelt

200740100	Kelt Reconditioning and Reproductive Success Evaluation Research	Columbia River Inter-Tribal Fish Commission (CRITFC)

AFEP Kelt Study[8]

AFEP 2014-04	Steelhead kelt passage distributions and FCRPS survival and return rates for fish tagged above and at Lower Granite Dam. (Year 3)	Adult Salmon and Steelhead Studies (Kelt)

Summary

The kelt life history stage of steelhead is important to population viability, but few if any kelts likely survive downstream passage through multiple dams, rearing in the ocean, and return migration to the natal river for spawning. Ongoing efforts in the Basin have demonstrated the ability to recondition kelts in a hatchery setting and for the reconditioned kelts to reproduce in the river. However, the contribution of the reconditioned kelts to population viability has not yet been demonstrated. In some areas, density dependence stemming from relatively high abundances of natural and hatchery spawners may limit the survival of progeny produced by kelts.

The PNNL AFEP steelhead kelt study directly addresses the critical uncertainty related to the hydrosystem: What are the effects of multiple dam passages and spill operations on adult fish migration behavior and survival rates? Behavior and survival of kelts through several passage routes was examined. Most kelts emigrated through surface spillways, few migrated through deep water spillways, and very few passed through turbines. Survival values were not provided in the abstract.

[8] AFEP 2014-08 refers to a presentation from the 2014 Annual Research Conference for the U.S. Army Corps of Engineers' Anadromous Fish Evaluation Program. This overview provides a snapshot of AFEP efforts and is *not* intended to be a comprehensive analysis of AFEP.

200740100 - Kelt Reconditioning and Reproductive Success Evaluation Research

Links to: project **and** reports

Proponent: Columbia River Inter-Tribal Fish Commission (CRITFC)

Province/subbasin: Columbia Plateau/Snake Lower

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- What approaches can help to reduce loss of life history diversity in steelhead populations?

Comment:

The objectives of this project are to evaluate methodologies to produce viable artificially reconditioned repeat steelhead spawners (kelts) and to determine the productivity of repeat spawners in the Yakima and Snake River basins. The investigators have shown that they can successfully recondition kelts and that the kelts can produce offspring. This project indirectly addresses the 2006 critical uncertainty involving the demographic benefit of supplementation. However, it also addresses a new critical uncertainty related to approaches to mitigate for loss of life history diversity (kelts are especially vulnerable to hydrosystem impacts) and fish propagation (best methods to mitigate hydrosystem impacts). Specific uncertainties related to this project also include (1) can kelt reconditioning meaningfully improve viability criteria for steelhead in the Basin, and (2) can domestication selection be minimized?

Methods: The investigators used long-term reconditioning of kelts in the hatchery. Methods seem appropriate and consistent with those used in a sister project for the Upper Columbia (2008-458-00), which was recently reviewed by the ISRP (2014). New modeling procedures have not yet been reviewed by ISRP.

Program Relevance and Project Results: This research project is an experimental approach to potentially enhancing steelhead abundance in the entire mid and upper Columbia River Basin, including the Snake River. Comparisons of fecundity, fertilization rate, and egg size variables revealed that repeat spawners had larger eggs and a greater abundance of eggs and no differences in fertilization rates were detected. Steelhead kelt re-maturation rates vary annually and spatially and range from 10.4% to 80.0%. Reproductive success of reconditioned steelhead was confirmed in the Yakima River with assignments of 23 juvenile fish to 11 unique parents. Five manuscripts have been published in addition to project reports.

The ISRP (2010) recommended that a thorough quantitative analysis of anticipated benefits to steelhead VSP parameters is needed as a foundation for pursuing steelhead kelt reconditioning as part of a kelt management effort. It was not clear to the ISRP that even under a robust definition of success for kelt reconditioning that the status of steelhead will be meaningfully improved.

In response, the proponents recently developed a model to examine population recovery from the perspective of a kelt reconditioning program. The model mimics iteroparity in ways explicit to body condition, reconditioning, and release method and shows that repeat spawners could contribute up to 10% of the spawning population if sufficient kelts are captured and reconditioned, consistent with existing data on survival and maturation rates and estimates of repeat spawner fecundity.

Broad Applicability: Kelt reconditioning methods identified in this study will likely have broad applicability, but the feasibility and benefits for steelhead recovery will depend on limiting factors such as stream hydrology, water supply, the proportions of kelts produced by target populations, and density dependence associated with large numbers of hatchery-origin spawners in rivers (e.g., upper Columbia River tributaries). Some areas, such as the upper Salmon River region, produce a disproportionate number of kelt steelhead within the Snake River.

Time Required: This project will reportedly operate for 12 years, thus encompassing 2 steelhead generations and 1 reference year-class.

Hatchery Program M&E

Select Area Fisheries Enhancement

199306000 - Select Area Fisheries Enhancement

Links to: project **and** reports

Proponent: Clatsop County Fisheries, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Columbia River Estuary/Columbia Estuary

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?

Comment:

The Select Area Fisheries Enhancement or SAFE project directly addresses two critical uncertainties regarding harvest and hatchery approaches that enable efficient harvest of hatchery salmon while minimizing undesirable harvests of migrating non-local wild salmon, including ESA-listed stocks. The SAFE project helps to mitigate for lost harvest opportunities in terminal areas of the lower Columbia River. The approach has the potential for broad application in the Basin. The Colville Tribes' mark-selective fishery is another approach designed to address the same critical uncertainties. Both approaches should be considered in other areas of the Basin.

Methods: In 2010, the ISRP provided comments on the SAFE program and documentation of impacts on ESA-listed stocks but concluded after receiving a response from the proponent that the project met scientific criteria.

Program Relevance and Project Results:

Project level monitoring: From 2008-2012, Select Area commercial fisheries have contributed an average of 50% of the spring Chinook, 77% of the coho, and 33% of the fall Chinook to the total non-Treaty Columbia River commercial harvest.

Average harvest rates of 94% for spring Chinook, 99% for coho, and 98% for fall Chinook produced by the SAFE project far exceed rates for production from other regional hatcheries which typically have high escapement rates due to complexities associated with harvest in mixed-stock fisheries of the mainstem Columbia River.

On average, 14% of spring Chinook, 42% of fall Chinook, and 31% of coho production from the SAFE project is harvested in other regional recreational and commercial fisheries.

Due to spatial separation, Select Area fisheries reportedly have far less impact on non-target stocks per harvested fish than do mixed-stock commercial and recreational fisheries occurring in the mainstem Columbia River, even when these fisheries utilize mark-selective harvest methods.

Stock composition in Select Area winter, spring, and summer commercial fisheries averages 88% local stock. Fall fisheries average 90% local Chinook stocks and 80% local coho stocks.

Broad Applicability: The SAFE approach (hatchery production located in an area separate from most wild salmon populations) has broad applicability but the monitoring data is site specific. Could this approach be used in Zone 6 (Tribal fisheries)?

Time Required: The 2013 season report is available. This project and the associated monitoring should continue in order to provide significant harvest opportunities while minimizing harvests of non-target natural origin salmon, especially ESA-listed stocks.

Hood River

198805303	Hood River Production Monitoring and Evaluation (M&E)-Warm Springs	Confederated Tribes of Warm Springs
198805307	Hood River Production Operations and Maintenance (O&M)-Warm Springs	Confederated Tribes of Warm Springs
198805304	Hood River Production Monitor and Evaluation (M&E)-Oregon Department of Fish and Wildlife (ODFW)	Oregon Department of Fish and Wildlife
198805308	Hood River Production Operations and Maintenance (O&M) and Powerdale	Oregon Department of Fish and Wildlife

Summary

The Confederated Tribes of the Warm Springs (CTWS) and Oregon Department of Fish and Wildlife (ODFW) are cooperatively managing spring Chinook and steelhead in the Hood River subbasin. Their actions can be subdivided into a hatchery component and efforts directed toward assessing the abundance, distribution, harvest and survival of salmonids within and downstream of the Hood River subbasin. The removal of the Powerdale Dam in 2010 created monitoring and broodstock collection challenges but also opportunities for natural production. Once the dam was removed it was no longer possible to collect steelhead and spring Chinook broodstock at Powerdale. Adults of both species are now collected at the Warm Springs' Moving Falls facility. A temporal overlap between runs was discovered when summer and winter steelhead reached maturation. This created a problem when steelhead were spawned as crosses between the two races were not desired. Genetic differences between the races were found, making it possible to identify the origin of potential broodstock. Now, tissue samples from prospective broodstock are analyzed to ensure that only winter steelhead are spawned. Steelhead and spring Chinook spawning and some early incubation typically takes place at the Warm Springs' Parkdale Hatchery. Eggs are then taken to ODFW facilities for additional incubation and rearing to the pre-smolt stage. They are then transported to acclimation sites located in the Hood River subbasin prior to being released.

The monitoring and evaluation work that takes place within the Hood River Subbasin is also performed collaboratively. Currently, Warm Springs' personnel are assessing the abundance of spring Chinook and steelhead parr during the summer low flow period to obtain estimates of carrying capacity. They perform annual spawning surveys for spring Chinook to document their abundance and distribution; collect environmental data to determine which parts of the subbasin can support salmonids; track the migration behavior of juvenile salmonids in the Hood River, the mainstem Columbia River, and into the estuary; assess smolt-to-adult survival; and are developing models to predict juvenile and adult abundance. They also assess tribal harvest of spring Chinook. ODFW staff estimate the abundance of downstream steelhead and spring Chinook migrants, ascertain the migration speed of smolts, assess residualism of hatchery winter steelhead, estimate adult abundance back to Bonneville Dam and the survival of adults from Bonneville to the Hood River. They are also formulating models that are being used to predict the abundance of two-year-old steelhead smolts in the subbasin. A niche model run by ODFW was used to establish which parts of the subbasin had suitable habitat for coho salmon. Non-tribal harvest of spring Chinook and steelhead are also estimated by ODFW. In combination the Warm Springs and ODFW are producing data that can be used to evaluate the Hood River hatchery programs for spring Chinook and winter steelhead and ascertain their status and temporal changes in abundance.

198805303 - Hood River Production Monitoring and Evaluation (M&E)-Warm Springs

Links to: project **and** reports

Proponent: Confederated Tribes of Warm Springs

Province/subbasin: Columbia Gorge/Hood

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?

Indirect or Potential:

- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?

Comment:

Uncertainty #1 was partially addressed. The project utilized a modified "Brakensiek Method" to estimate the abundance of salmonid parr during the summer low-flow period which was perceived as a bottleneck for juvenile production. This approach was successful in generating population density and abundance estimates for spring Chinook and rainbow/steelhead juveniles. These estimates approximate the carrying capacity during the low-flow period. However, it was not disclosed whether the estimates are helping establish supplementation goals in the Hood River subbasin.

Uncertainty # 2 is by and large being assessed. Spring Chinook were reintroduced to the Hood River and annual spawning ground surveys are being conducted to document which portions of the subbasin are being recolonized. The surveys also record the origin of recovered carcasses—natural or hatchery. Over time the surveys will provide a picture of the areas in the subbasin utilized by spring Chinook and the possible creation of quasi-isolated spawning populations. Associations among where, when, and how many hatchery smolts were released into the Hood River subbasin and how that influenced recolonization will need to be made to provide complete information for this uncertainty.

Uncertainty #3 was indirectly addressed. Natural- and hatchery-origin spring Chinook and steelhead juveniles are PIT tagged and their migration behavior to the Columbia estuary and survival to the adult stage is being compared. Hatchery production information is available, but no linkages between the survival of natural origin fish and hatchery releases are described.

Methods: This project is examining a number of issues regarding fish passage, efficacy of trapping, survival and migration of smolts in the Hood River system. PIT tags, for instance are being used to track migration behavior and estimate survival of hatchery- and natural-origin steelhead and spring Chinook smolts to Bonneville Dam and the estuary. PIT tags are also being used to estimate smolt-to-adult survival rates (SARs) to Bonneville for both species. Water temperature (via loggers) and flow data (via seasonal sampling with current meters) are being collected in multiple parts of the subbasin. Multiple regression models using evolving predictor variables are being employed to forecast adult and juvenile abundance of steelhead and spring Chinook. The models are validated on a regular basis and predicator variables are changed as needed. A single access point creel survey is being used to monitor Tribal harvest of hatchery spring Chinook. Typical methods are being employed to conduct spawning ground surveys for spring Chinook (i.e. redds are counted, flagged, GPS coordinates for redd locations are taken, carcasses are examined for tags/marks, gamete retention, length etc.). Snorkeling methods are being used to examine the distribution of spring Chinook parr in the subbasin. A modified Brakensiek Method is being applied to estimate rearing densities of spring Chinook and steelhead parr in selected areas of the subbasin. Analyses of tissue samples collected from migrating steelhead smolts indicated it was possible to distinguish summer from winter run fish. All methods appear to be appropriate.

Program Relevance and Project Results: This is a monitoring study that provides information on survival and movement of salmonids in the Hood River system. Data collected on smolts and adult spring Chinook and steelhead (winter and summer populations) both hatchery- and natural-origin are being employed to track status and trends in abundance and survival. Environmental data are being evaluated to ascertain if water temperatures in portions of the basin are exceeding temperature limits established by ODEQ. Genetic analyses performed on tissue samples of steelhead smolts showed that it will be possible to separate summer from winter-run fish. This will make juvenile abundance estimates for both races possible—a significant improvement over a past limitation.

Broad Applicability: Most of the monitoring and evaluation activities reported are specific to the Hood River. The work being done, however, provides the project with data that portray how demographic parameters in salmonid populations fluctuate with environmental variation. Consequently, it provides fundamental information to Hood River fisheries managers and helps refine recovery goals for the basin. Many of the methods being used by the project are employed in other subbasins. Yet the method being utilized to estimate steelhead and spring Chinook parr abundance and identify possible limiting factors during summer low-flow periods appears to be unique to the project. It may be one that could be exported to other subbasins.

Time Required: Monitoring and evaluation will need to be carried out into the foreseeable future.

198805307 - Hood River Production Operations and Maintenance (O&M)-Warm Springs

Links to: project **and** reports

Proponent: Confederated Tribes of Warm Springs

Province/subbasin: Columbia Gorge/Hood

2006 Research Plan uncertainties addressed: None

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Fish Propagation: Is it feasible to rear two-year old steelhead smolts?

Comment:

None of the uncertainties listed in the 2006 Research Plan were addressed by this project.

Methods: This was an annual operations and maintenance report for the Parkdale Fish Hatchery and its satellite facility, Moving Falls Fish facility. Broodstock for the Hood River spring Chinook supplementation program are now being collected at Moving Falls. Prior to 2010 those collections had taken place at the Powerdale Dam. But the dam was removed in 2010 making broodstock collections somewhat difficult.

Program Relevance and Project Results: A fish cultural uncertainty about the feasibility of rearing two-year old steelhead smolts is being investigated. Steelhead eggs collected in 2014 were put into a "sentinel" fish project. This project is an attempt to rear two-year-old steelhead smolts by using rearing facilities at both the Moving Falls facility and the Parkdale Hatchery. Also the steelhead kelt recondition investigations that had taken place at the Parkdale Hatchery were terminated.

Broad Applicability: This is a site-specific reporting of activities associated with the Parkdale hatchery

Time Required: Similar annual reports covering the activities at the Parkdale Hatchery and its satellite, the Moving Falls Fish facility will take place for the foreseeable future.

198805304 - Hood River Production Monitor and Evaluation (M&E)-Oregon Department of Fish and Wildlife (ODFW)

Links to: project **and** reports

Proponent: Oregon Department of Fish and Wildlife

Province/subbasin: Columbia Gorge/Hood

2006 Research Plan uncertainties addressed:

Direct:

- Harvest: What new harvest and escapement strategies can be employed to improve harvest opportunities and ecological benefits within the Columbia Basin while minimizing negative effects on ESUs or populations of concern? Can genetic techniques be used to quantify impacts on wild or ESA-listed stocks in ocean fisheries?

Indirect or Potential:

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Comment:

Uncertainty #1 is being partially assessed. The removal of the Powerdale Dam opened parts of the Hood River subbasin that had not been available previously to non-tribal anglers. As a result the project redesigned its creel surveys, produces semi-monthly and annual harvest estimates, and offers new harvest opportunities. None of the other aspects of this uncertainty are addressed.

Uncertainty #2 is being indirectly assessed as data collected on juvenile and adult hatchery, and natural origin steelhead and spring Chinook could be used to answer this uncertainty.

Methods: A number of monitoring and evaluation gaps for Chinook, steelhead, and coho occurred in the Hood River basin after the Powerdale Dam was removed. Currently, the project is employing a variety of methods (pooled Petersen population estimates, Cormack-Jolly-Seber (CJS) open population models, multiple regressions and PIT tag interrogation records) to estimate: (a) the abundance of downstream salmonid migrants, (b) juvenile survival, (c) migration speed of juveniles, (d) residualism of hatchery winter steelhead and (e) the relationship between a suite of variables (e.g. flow, parental abundance, juvenile size at migration) on annual abundance of age-2 steelhead smolts. Modified Petersen estimates were also used to assess adult (steelhead and spring Chinook) abundance to Bonneville Dam, and CJS models were utilized to estimate the survival of those fish back to the Hood River. A mark-recapture estimate using radio-tagged adult steelhead was also employed to make an in-river population estimate of winter steelhead. A niche model (MaxEnt) was run to identify where coho might distribute themselves in the basin. The MaxEnt model was also employed to gain insights on the potential spatial distribution of steelhead in the Hood River subbasin. All appear to be appropriate methods for the types of data needed. Point estimates had accompanying 95% confidence intervals.

Program Relevance and Project Results: Results from the project are allowing status and trends data to be acquired on steelhead and spring Chinook and are showing the effects of the removal of the Powerdale dam on salmonid productivity in the basin. The MaxEnt modeling exercise indicated that habitat suitable for coho was largely restricted to Neal Creek. Before the model was run, managers had hypothesized that coho habitat would be more extensive.

Broad Applicability: Many of the methods used by the project could be used by other monitoring and evaluation projects in the Columbia River Basin if they are not already being employed. The MaxEnt Model, for example, could be useful in other subbasins. Additionally, the effect of dam removal on salmonid populations is a topic of critical importance. This study informs factors involved in time to recovery and appropriate management actions following dam removal.

Time Required: Monitoring should be ongoing to evaluate success of stocking plans and other management activities.

198805308 - Hood River Production Operations and Maintenance (O&M) and Powerdale

Links to: project **and** reports

Proponent: Oregon Department of Fish and Wildlife

Province/subbasin: Columbia Gorge/Hood

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?

Comment:

The project indirectly addresses the 2006 uncertainty listed above by rearing hatchery steelhead that are subsequently being used in a relative reproductive study taking place in the Hood River subbasin.

Methods: Two annual reports were examined. The most recent one was an operations plan for ODFW'S Oak Springs Hatchery. The report indicated that hatchery winter steelhead gametes collected from fish spawned at the Parkdale Hatchery (Hood River) were transferred to the Oak Springs facility, reared to about 90 g, and then transported back to two acclimation sites located in the Hood River basin prior to being released. All the fish are fin clipped prior to being transferred.

The second report, which was issued on 2008, describes genetic work performed by the USFWS on Hood River winter and summer run steelhead. An overlap in adult return timing exists between these two races of steelhead and there was concern that crosses between the two races were occurring in the hatchery. Microsatellite variation was successfully used to genetically separate the two groups of fish.

Program Relevance and Project Results: The project annually provides winter steelhead smolts to two acclimation sites, 25,000 to the Parkdale Hatchery and 25,000 to the East Fork Irrigation Acclimation pond. These fish are incorporated into a relative reproductive study that is taking place at Hood River. The ability to genetically identify summer and winter steelhead has altered how spawning operations occur at the Parkdale Hatchery. Now, prospective broodstock are held at the hatchery until genetic analyses (48 hr) assign them to one of the two races. If any uncertainty about the racial origin of a fish occurs it is not used as broodstock. A manuscript describing the method was submitted to a peer-reviewed journal

Broad Applicability: The activities described above are restricted to the Hood River subbasin

Time Required: These actions will continue into the foreseeable future.

Umatilla

199000500	Umatilla Hatchery Monitoring and Evaluation (M&E)	Oregon Department of Fish and Wildlife
199000501	Umatilla Basin Natural Production Monitoring and Evaluation (M&E)	Umatilla Confederated Tribes (CTUIR)
198902401	Evaluate Umatilla Juvenile Salmonid Outmigration	Oregon Department of Fish and Wildlife

Summary

These three projects are closely integrated with each other and complement habitat research conducted as part of the Intensively Monitored Watershed program. The projects monitor the performance and success of the Umatilla hatchery program for Chinook and steelhead, track trends in productivity of natural origin fish populations, produce statistically valid estimates of viability parameters for the steelhead population, and guide management activities in the Umatilla subbasin.

In concert, they address a number of the 2006 critical uncertainties including how tributary habitat restoration actions affect native fish populations and the carrying capacity of freshwater habitat, examine ways to reduce interactions between hatchery and natural origin fish, and assess the magnitude of demographic benefits from supplementation. The projects were designed, in part, to evaluate the 2008 implementation of HSRG recommendations for hatchery reform strategies aimed at establishing locally adapted natural spring and fall Chinook salmon populations. The hatchery M&E project also supports a collaborative experiment with researchers from NOAA Fisheries to more accurately gauge the percentage of precocious individuals within a brood and to investigate whether hatchery rearing methods can be used to reduce the number of minijacks that are produced.

Results to date suggest that habitat conditions and density dependent survival are constraining the increase in smolt production that was anticipated from supplementation and habitat restoration. It appears that any benefits to the steelhead population resulting from habitat restoration in tributary streams such as Meacham Creek and Birch Creek may be negated by survival bottlenecks once they enter the Umatilla River. Annual reports are up-to-date (to 2014) and well organized, and they provide considerable detail about activities and results for the year in question. Retrospective discussion and updated time series of data are also provided in tables and figures.

These are long-term projects and continued monitoring of status and trends is warranted.

199000500 - Umatilla Hatchery Monitoring and Evaluation (M&E)

Links to: project **and** reports

Proponent: Oregon Department of Fish and Wildlife

Province/subbasin: Columbia Plateau/Umatilla

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Indirect or Potential:

- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?

Comment:

This project directly addresses the 2006 critical uncertainties about fish propagation related to reducing interactions between hatchery and natural origin fish, understanding changes in the natural-spawning fitness of hatchery origin fish, and assessing the magnitude of demographic benefits from supplementation.

The project is closely integrated with three other projects (natural production monitoring, outmigration monitoring and Intensively Monitored Watershed habitat research) and indirectly addresses the 2006 uncertainties about how tributary habitat restoration actions affect native fish populations (an experimental design is described), and the carrying capacity of freshwater habitat. As well, it was designed in part to evaluate the 2008 implementation of HSRG recommendations for hatchery reform strategies aimed at establishing locally adapted natural spring and fall Chinook salmon populations.

Results from the project could potentially help to address additional uncertainties related to strategies to improve harvest opportunities and ecological benefits (the project involves non-tribal creel surveys and estimation of out-of-basin catch), the effects of hydrosystem operations on fish survival and behavior, and the relationship between basinwide hatchery production and the productivity of naturally produced fish (hatchery fish are marked and enumerated).

Methods: Monitoring and evaluation methods seem appropriate and include (non-tribal) creel surveys, mark-recapture, and eventually parent-based tagging to evaluate outmigration and returns for major salmonid fisheries in the Umatilla Basin. Results generally include statistical tests and confidence intervals to show precision.

Program Relevance and Project Results: This comprehensive project is primarily focused on monitoring status and trends and is closely integrated with 2 other projects (natural production monitoring and evaluation, and outmigration monitoring). It monitors the performance and success of the Umatilla hatchery program for Chinook and steelhead and guides management activities in the Umatilla subbasin. The focus has shifted away from hatchery rearing practices to evaluation of release sizes and acclimation and release locations, timing and strategies on juvenile survival and adult production. The project now includes monitoring of Umatilla recreational fisheries, out-of-subbasin contributions to commercial, tribal and recreational fisheries, productivity of hatchery fish, outmigration and survival of hatchery juveniles, fish marking and tagging, straying of hatchery adults, pre-season run predictions, and adult production. This monitoring effort provides important feedback to regional management efforts because it assesses how natural populations of steelhead and two life history types of Chinook are responding to a variety of conditions, including in-river habitat, flow, migration corridors, and ocean conditions.

The project also supports a collaborative experiment with researchers from NOAA Fisheries to more accurately gauge the percentage of precocious individuals within a brood, and to investigate whether hatchery rearing methods can be used to reduce the number of minijacks that are produced.

The project is rearing separate Conservation and Harvest Groups of spring Chinook to establish a sustainable locally adapted population. This effort was started in 2009. Managers began a similar program for fall Chinook, but high harvest rates made it impractical to establish a Conservation population for this race of Chinook. It was also observed that the survival of Umatilla Hatchery steelhead to adulthood was low when compared to nearby hatchery programs. Relatively high rearing densities at the Umatilla Hatchery were identified as a possible cause. However, the need to meet release goals has stymied efforts to reduce rearing densities at the hatchery. Instead, managers agreed to change the composition of the steelhead broodstock. The original protocol was to use 100% natural origin fish. Beginning 2014, up to one-third of the broodstock will consist of hatchery-origin fish. This is being done in the belief that this new protocol will increase post-release survival rates. The effect of this shift is not being evaluated experimentally. Instead the survival of steelhead released in 2015 and beyond will be monitored to see if the new broodstock protocol is producing its intended effect.

*Reporting***:** Annual reports are up-to-date (to 2014), well organized and provide considerable detail about activities and results for the year in question. Retrospective discussion and updated time series of data are also provided in tables and figures.

Broad Applicability: This suite of projects focuses on status and trends of Chinook and steelhead in the Umatilla River subbasin, but evaluation of outcomes of habitat restoration and hatchery reform there could generalize to comparable subbasins.

Time Required: This is a long-term project and continued monitoring of status and trends is warranted.

199000501 - Umatilla Basin Natural Production Monitoring and Evaluation (M&E)

Links to: project **and** reports

Proponent: Umatilla Confederated Tribes (CTUIR)

Province/subbasin: Columbia Plateau/Umatilla

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Indirect or Potential:

- Climate Change: Can indices of climate change be used to better understand and predict interannual and interdecadal changes in production, abundance, diversity, and distribution of Columbia Basin fish and wildlife?
- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Harvest: What new harvest and escapement strategies can be employed to improve harvest opportunities and ecological benefits within the Columbia Basin while minimizing negative effects on ESUs or populations of concern? Can genetic techniques be used to quantify impacts on wild or ESA-listed stocks in ocean fisheries?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?

- Mainstem Hydrosystem Flow and Passage Operations: What are the optimal temperature and water quality regimes for fish survival in tributary and mainstem reaches affected by dams, and are there options for hydrosystem operations that would enable these optimal water quality characteristics to be achieved? What would be the effects of such changes in operations and environment on fish, shoreline and riparian habitat, and wildlife?

Comment:

The project is closely integrated with three other projects (hatchery monitoring, outmigration monitoring and Intensively Monitored Watershed habitat research), which together directly address the 2006 critical uncertainties about how tributary habitat restoration actions affect native fish populations (an experimental design is described) and the carrying capacity of freshwater habitat (density dependence is evaluated and reported). Through integration with other projects, it indirectly addresses the 2006 critical uncertainties related to reducing interactions between hatchery and natural origin fish, and assessing the magnitude of demographic benefits from supplementation. As well, it was designed in part to evaluate the 2008 implementation of HSRG recommendations for hatchery reform strategies aimed at establishing locally adapted natural spring and fall Chinook salmon populations.

Results from the project could potentially help to address additional 2006 critical uncertainties related to the effects of hydrosystem operations on fish survival and behavior, strategies to improve harvest opportunities and ecological benefits, and to use indices of climate change to understand and predict interdecadal changes in fish production, distribution, and diversity.

Methods: Monitoring and evaluation methods seem appropriate and were favorably reviewed by the ISRP (2010).

Program Relevance and Project Results: This project is closely integrated with 4 other projects (hatchery monitoring, outmigration monitoring and IMW work). It provides data from redd surveys and water temperature monitoring throughout the Umatilla River Basin, and from creel surveys on tribal lands not provided in other coordinating studies.

The ISRP (2010) concluded: “This project provides critical information about the natural production of steelhead and Chinook salmon in the Umatilla River basin. The data generated can be used to assess the effects of habitat restoration, flow restoration, and hatchery supplementation on populations of wild fish. In addition, it should provide important data by which to judge the new integrated hatchery supplementation strategies, whereby two different groups (Conservation and Harvest) of smolts are produced from natural vs. hatchery parents, respectively.”

The project has explicitly addressed uncertainties related to density dependence. The adult-to-adult stock recruitment relationship for summer steelhead suggests habitat and not adult spawners limit natural adult returns. High summer water temperatures are suggested as a primary limiting factor for salmonids in many stream reaches. Naturally produced steelhead returns have been variable but have increased overall since the early 1990s. Hatchery steelhead returns have been variable but static overall.

The ratio of hatchery origin steelhead has declined from a high of 60% of the run in 1996 to about 25% since 2008.

Reporting: Annual reports are up-to-date (to 2014), well organized and provide considerable detail about activities and results for the year in question. Retrospective discussion and updated time series of data are also provided in tables and figures. Summaries of results overlap or are duplicated in reports from the two other closely integrated projects. Summaries, conclusions, and recommendations for adaptive management could be more clearly stated.

Broad Applicability: This suite of projects focuses on status and trends of Chinook and steelhead in the Umatilla River subbasin, but evaluation of outcomes of habitat restoration and hatchery reform there could generalize to comparable subbasins.

Time Required: This is a long-term project that began around 1990. Continued monitoring is warranted to extend the time series of post-treatment effects or to evaluate the effect of future habitat improvements in the system.

198902401 - Evaluate Umatilla Juvenile Salmonid Outmigration

Links to: project **and** reports

Proponent: Oregon Department of Fish and Wildlife

Province/subbasin: Columbia Plateau/Umatilla

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Indirect or Potential:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species and stocks? What are the ecological effects of hydrosystem operations on downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?

Comment:

The project is closely integrated with three other projects (hatchery monitoring, natural production monitoring, and Intensively Monitored Watershed habitat research) which together directly address the 2006 critical uncertainties about determining carrying capacity of freshwater habitat (density dependence is reported) and how tributary habitat restoration actions affect native fish populations (an experimental design is described). Collectively these projects also directly address two additional 2006 uncertainties about fish propagation related to reducing interactions between hatchery and natural origin fish and assessing the magnitude of demographic benefits from supplementation. As well, this project was designed in part to evaluate the 2008 implementation of HSRG recommendations for hatchery reform strategies aimed at establishing locally adapted natural spring and fall Chinook salmon populations.

Results from the project could potentially help to address additional uncertainties related to the effects of hydrosystem operations on fish survival and behavior.

Methods: Monitoring methods seem appropriate. Two fixed site traps, PIT tags, fish ladder PIT-tag scanners, radio telemetry, and mark-recapture methods are used to assess trends in juvenile abundance, to estimate survival rates and productivity, and to monitor life history characteristics for steelhead in the Umatilla River and Three Mile Falls Dam areas. The design of the Intensively Monitored Watershed project allows comparisons between two treatment streams and a reference stream to assess effectiveness of habitat restoration in the treatment streams. Data analyses will integrate life stage specific survival and life history information to derive and assess key performance metrics.

However, the lack of reference conditions before habitat restoration and multiple management actions make it difficult to evaluate the response of the Umatilla River steelhead population to any specific management action. ISRP (2010) concluded: "One of the limitations …is the uncertainty of the degree of hatchery influence which could affect comparability of the treatment and reference streams. Another potential problem is that habitat restoration actions in the treatment streams have been ongoing for some time. The effects of these actions will continue beyond the initiation of the IMW project making it difficult to separate biological and habitat responses resulting from pre-treatment habitat enhancement actions from those occurring post-treatment, after project initiation. This residual effect of pre-treatment actions may complicate before-after comparisons."

Program Relevance and Project Results: This project provides annual estimates of smolt abundance, migration timing and survival, and life history characteristics for all anadromous salmonid species in the Umatilla River basin. The information is used to monitor hatchery contributions and trends in productivity of natural origin fish populations, and to produce statistically valid estimates of viability parameters for the steelhead population. The project also supports assessments of the spatial distribution and diversity of natural and hatchery origin fish populations.

The project is also designed to monitor the response of the natural steelhead population to watershed-scale habitat restoration, to enable rigorous assessments of temporal habitat changes at multiple spatial scales, and to evaluate the 2008 implementation of HSRG recommendations for hatchery reform strategies aimed at establishing locally-adapted natural spring and fall Chinook salmon populations.

Results to date suggest that habitat conditions and density dependent survival are restricting the increase in smolt production that was anticipated from supplementation and habitat restoration. Survival estimates standardized for distance traveled suggest that natural summer steelhead experience 4-7 times higher mortality in the Umatilla River than in the Grande Ronde, Minam, and Lostine rivers. The cumulative effects of passage through bypass facilities and exposure to predators are poorly understood. It appears that any benefits to the steelhead population resulting from habitat restoration in tributary streams such as Meacham Creek and Birch Creek may be negated by survival bottlenecks once they enter the Umatilla River.

This project provides evidence for density-dependent population regulation. Analysis of long-term production and survival data showed that larger numbers of spawning female steelhead were associated with reduced numbers of smolts-per-female and a decreasing trend for egg-to-smolt survival has persisted.

Reporting: Annual reports are up-to-date (to 2014) and well organized, and they provide considerable detail about activities and results for the year in question. Retrospective discussion and updated time series of data are also provided in tables and figures.

Broad Applicability: The project focuses on status and trends of steelhead in the Umatilla River, but the evaluation of outcomes of hatchery reform and habitat restoration there could generalize to comparable subbasins. Synthesis with monitoring efforts elsewhere might also help to identify general conditions that create demographic bottlenecks and limit the efficacy of habitat restoration to improve productivity and carrying capacity.

Time Required: Initial studies for this long-term project began in 1989 to evaluate the passage of juvenile fish at irrigation diversion facilities. Funding for the Outmigration and Survival Project was eliminated in 2007, then restored following ISRP review in 2009, but with a narrowed focus on ESA-listed Umatilla River steelhead. Continued monitoring is warranted to extend the time series of post-treatment effects, or to evaluate the effect of future habitat improvements in the system.

Yakima and Klickitat Fisheries Project

199506335	Klickitat River Monitoring and Evaluation-Yakima/Klickitat Fisheries Project (YKFP)	Yakama Confederated Tribes
199506325	Yakima River Monitoring and Evaluation-Yakima/Klickitat Fisheries Project (YKFP)	Yakama Confederated Tribes

199506335 - Klickitat River Monitoring and Evaluation-Yakima/Klickitat Fisheries Project (YKFP)

Links to: project **and** reports

Proponent: Yakama Confederated Tribes

Province/subbasin: Columbia Gorge/Klickitat

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Harvest: What new harvest and escapement strategies can be employed to improve harvest opportunities and ecological benefits within the Columbia Basin while minimizing negative effects on ESUs or populations of concern? Can genetic techniques be used to quantify impacts on wild or ESA-listed stocks in ocean fisheries?

Comment:

The Klickitat M&E project gathers baseline information on habitat quantity and quality, and demographics, life history and abundance of Klickitat spring Chinook, steelhead, and other species of interest (non-native coho and fall Chinook). Methods of estimating the variable production of natural salmon are being developed. The project documents status and trends of hatchery and wild origin salmonids in the Klickitat Basin, as a means to inform management of the natural and hatchery populations. The information could potentially be used to address each of the critical uncertainties listed above, but the annual monitoring report does not specifically address these issues.

Methods: In 2006, the ISRP noted that "this project is designed to monitor and evaluate fisheries enhancement projects; however, it is not clear that data being collected directly relate to this objective" and that the project met scientific review criteria, in part. In 2013, the ISRP conducted a review of the Yakama Nation's response to the ISRP's Step 2 review of the *Klickitat River Anadromous Fisheries Master Plan* (project 1988-115-35) and requested additional M&E information that would stem from Project 1995-063-35.

Methods include monitoring adult salmonid population sizes, demographics, and spatial distribution via spawner surveys, adult salmonid trapping at the Lyle Falls Fishway on the lower Klickitat River, and radio telemetry. Juvenile and resident salmonid monitoring – monitoring outmigration, survival, spatial distribution, and life history patterns via smolt trapping, stream population surveys, and PIT tagging. Genetic analysis via microsatellite DNA data, and monitoring physical habitat parameters via habitat surveys, sediment, temperature, water quality, and streamflow monitoring.

Program Relevance and Project Results:

Status and Trend M&E: Mark-recapture run size estimates at Lyle Falls at river mile (RM) 2.4 on the Klickitat River indicate a depressed adult return of wild spring Chinook, averaging about 500 fish including adults and jacks from 2007-2012. A potentially large percentage of spawners on natural spawning grounds are hatchery-origin fish.

Mark-recapture estimates for steelhead returns to Lyle Falls from 2005-2012 indicate an average of about 1600 wild steelhead and 2900 hatchery steelhead. This may meet National Marine Fisheries Service (NMFS)-recommended mean minimum abundance criteria for this ESA-listed stock, but it may not meet broader-sense recovery goals as defined by regional recovery partners and co-managers. Stray or "dip-in" rates for steelhead are high for steelhead entering the lower river. Natural-origin and hatchery-origin steelhead sampled as adults and juveniles appear to remain genetically distinct suggesting low introgression/interbreeding rates.

Redd counts and carcass recovery results for fall Chinook and coho indicate both populations are largely sustained by hatchery production.

This project provides important baseline data to evaluate hatchery management activities, habitat restoration projects, and other changes in the basin, including climate change. However, these topics and other critical uncertainties listed above were not directly addressed in the project report.

Broad Applicability: Specific to the Klickitat River.

Time Required: The most recent report available from Taurus covered 2010 to 2012 activities. Continued M&E is needed to monitor interactions between hatchery and natural origin salmonids.

199506325 - Yakima River Monitoring and Evaluation-Yakima/Klickitat Fisheries Project (YKFP)

Links to: project **and** reports

Proponent: Yakama Confederated Tribes

Province/subbasin: Columbia Plateau/Yakima

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Fish Propagation: What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles and from harvest in fisheries targeting hatchery-origin adults?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Indirect or Potential:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Does an integrated hatchery approach lead to greater production of minijacks?

Comment:

The Yakima River M&E project was established to evaluate critical uncertainties associated with spring Chinook supplementation in the Yakima Basin, including interactions with natural salmon and native trout. The M&E project collects information associated with the supplementation of spring Chinook, including ecological interactions and ecological risk containment monitoring, domestication monitoring, genetic monitoring, competition/capacity/habitat saturation monitoring, natural production monitoring, and relative reproductive success evaluations.

The project directly addresses critical uncertainties #1 (partial; density dependence examined but no information on management response to this effect), #2 (effects of domestication examined and PNI strategy developed), #3 (effects of supplementation on native trout), #4 (partial; published study concluded no disease caused by hatchery Chinook), and #5 (increased spawners via supplementation did not produce significantly more natural origin adults). It also addressed a new critical uncertainty (see Project 2002-031-00 Growth Modulation-NOAA Fisheries). The project report provides less information directly related to the other uncertainties listed above.

Methods: In 2010, the ISRP concluded that this very large and complex M&E project met scientific review criteria with some qualifications. Specifically, the project should standardize calculations/metrics for determining impacts of supplementation, as presented in the Ad Hoc Supplementation Work Group reports and ISRP supplementation reports. Also much improved understanding is needed regarding factors that impact survival of natural- and (post-release) hatchery-origin juveniles in the basin. Links to specific protocols contained little information.

Program relevance and brief summary of findings:

Status and Trend M&E: The M&E project was designed to evaluate the YKFP progress towards addressing these four questions:

1. Can integrated hatchery programs be used to increase long-term natural production?
2. Can integrated hatchery programs limit genetic impacts to non-target Chinook populations?
3. Can integrated hatchery programs limit ecological impacts to non-target populations?
4. Does supplementation increase harvest opportunities?

According to the annual report (the ISRP and ISAB did not critique the following statements), preliminary results suggests operating the YKFP's production program has provided a demographic benefit to the population, has not impacted fish taxa beyond acceptable levels and the risk containment monitoring program is working as planned, some small levels of domestication in the context of predation vulnerability and competitive dominance have occurred, genetic stock partitioning of mixed stock smolt migrants remains a viable method to estimate population specific juvenile chinook smolt abundance and productivity, rearing habitat saturation has likely been met in several years under current conditions (i.e., capacity has been reached), and low levels of naturally produced precociously maturing chinook have been observed on the spawning grounds. Density dependent growth and survival of spring Chinook was shown in the 2009 M&E report, but the results of this analysis apparently have not influenced management. A new journal publication reported that supplementation led to increased harvests, redd counts, and spatial distribution, but natural origin returns did not significantly increase in response to supplementation (Fast, David E., William J. Bosch, Mark V. Johnston, Charles R. Strom, Curtis M. Knudsen, Anthony L. Fritts, Gabriel M. Temple, Todd N. Pearsons, Donald A. Larsen, Andrew H. Dittman & Darran May. 2015. A Synthesis of Findings from an Integrated Hatchery Program after Three Generations of Spawning in the Natural Environment, North American Journal of Aquaculture, 77:3, 377-395).

In other words, increasing spawning abundances via supplementation did not produce significantly greater adult natural-origin returns. The sex ratio of hatchery and natural origin Chinook was similar suggesting to the investigators that high minijack production in the hatchery smolt stage did not alter the sex ratio. Hatchery fish did not affect pathogens in natural Chinook.

Like other similarly designed fish monitoring studies in the Columbia Basin, this study provides potentially critical data to estimate and provide a time series for a number of key demographic, ecological, and evolutionary metrics for spring Chinook salmon. For genetic monitoring, this program uses microsatellite data for parentage analysis -- 97% success at confident assignment. We did not see a plan to convert to SNPs to better integrate findings with other genetic monitoring efforts in the Columbia River Basin.

Broad Applicability: These data provide a critical baseline to assess the success of various management activities in the Yakima Basin. Results from the project have been presented in public and professional forums and are intended to inform others throughout the region on the information learned under the project.

Time Required: The M&E project is likely to continue for a long time. This summary was based on data collected during 2012 and 2013 and reported in 2014.

Tucannon

201005000 - Evaluation of the Tucannon endemic program

Links to: project **and** reports

Proponent: Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Columbia Plateau/Tucannon

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Comment:

This project, along with LSRCP and BPA Project #2010-42-00, will provide estimates of natural and hatchery-origin summer steelhead in the spawning escapement and in the juvenile outmigration to quantify trends and fluctuations in steelhead abundance in the Tucannon River. Production trends will be used to evaluate critical uncertainties regarding the hatchery supplementation program and various habitat improvement projects in the subbasin. Results will provide managers with the necessary data to make future program changes (i.e., numbers of fish, release locations, harvest rules, etc.). It is anticipated that the project will directly address the two critical uncertainties listed above (supplementation, habitat effects) but this relatively new project does not yet attempt to directly address these issues.

Methods: In 2010, the ISRP reported that the project met scientific review criteria with the qualification that it should be included in the CRHEET supplementation evaluation umbrella. The project was also reviewed by the ISRP during its 2013 review of steelhead in the Lower Snake River Compensation Program.

Program relevance and brief summary of findings:

Status and Trend M&E: Hatchery and wild steelhead population data have been collected. On average, 74% of the adult steelhead on the spawning grounds are hatchery origin fish. Estimates of adult productivity are not yet available. Natural origin returns to the Tucannon are lower than natural origin stray and out-of-basin hatchery origin returns. This could have important genetic implications. A large portion of Tucannon steelhead overshoot the Tucannon River and migrate upstream to Lower Granite Dam. The reason for this behavior is not yet known, but researchers suspect the migratory route of steelhead as they approach the mouth of the Tucannon River, high water temperatures and low flows from the Tucannon River, cold water augmentation from Dworshak Reservoir, and the long period before spawning all play into the problem. Mean length of steelhead smolts has steadily decreased since 2000. Density dependence was not yet examined as a potential cause in the decline in size.

The BiOp calls for monitoring the effectiveness of the Tucannon River endemic steelhead program. Concurrent with that decision, releases of Lions Ferry Hatchery stock steelhead (used for harvest mitigation under the LSRCP) into the Tucannon River were stopped.

Broad Applicability: Primarily related to steelhead in the Tucannon River.

Time Required: A report covering 2014 and previous years was available. Continued M&E effort is needed to track steelhead supplementation and the response of the natural population.

Grande Ronde

199800702	Grande Ronde Supplementation Operations and Maintenance (O&M) and Monitoring and Evaluation (M&E) on Lostine River	Nez Perce Tribe
199800704	Grande Ronde Spring Chinook on Lostine/Catherine Creek/ Upper Grande Ronde Rivers	Oregon Department of Fish and Wildlife
199800703	Grande Ronde Supplementation O&M on Catherine Creek/Upper Grande Ronde River	Umatilla Confederated Tribes (CTUIR)
200708300	Grande Ronde Supplementation Monitoring and Evaluation (M&E) on Catherine Creek/Upper Grande Ronde River	Umatilla Confederated Tribes (CTUIR)
199202604	Grande Ronde Early Life History of Spring Chinook and Steelhead	Oregon Department of Fish and Wildlife
200740400	Spring Chinook Captive Propagation-Oregon	National Oceanic and Atmospheric Administration, Oregon Department of Fish and Wildlife

Summary

In the mid-1990s it was recognized that spring Chinook endemic to the Grande Ronde subbasin were on the verge of extirpation. This prompted the Oregon Department of Fish and Wildlife (ODFW), NOAA, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and the Nez Perce Tribe to begin a spring Chinook supplementation effort. Because fish numbers were so low, a captive brood program was initially started. Naturally produced spring Chinook parr were captured, reared to maturity, and artificially spawned. When their F_1 progeny reached the smolt stage, they were released from acclimation sites located in the Grande Ronde subbasin. A conventional hatchery program that used spring Chinook returning to the Grande Ronde River as broodstock was started several years later. Currently the program is collecting adults returning to Catherine Creek, the Upper Grande Ronde, Lostine River, and Lookingglass Creek and using them as broodstock. ODFW operates the Lookingglass hatchery where incubation and rearing takes place to the smolt stage. Smolts are transported to acclimation sites in Catherine Creek, the Upper Grand Ronde, and Lostine River and allowed to volitionally exit several days after introduction into an acclimation site. Nez Perce researchers are evaluating the success of this program in the Lostine River while CTUIR personnel perform similar assessments in the upper Grande Ronde and Catherine Creek. CTUIR personnel also collect broodstock and operate the acclimation sites located in the upper Grande Ronde and Catherine Creek. Significant habitat restoration efforts are occurring in the subbasin and ODFW has partnered with the Columbia River Habitat Monitoring Program (CHaMP) to determine if relationships between restoration actions and salmonid abundance can be established. The infrastructure (weirs and rotary screw traps) employed to compare and assess the survival and migration characteristics of hatchery- and natural-origin spring Chinook juveniles and adults have also allowed information on Grande Ronde summer steelhead to be collected. In general, Grande Ronde summer steelhead exhibit typical type-A steelhead life histories.

The captive brood program was stopped in 2008 due to increases in adult abundance. However, a “safety net” program was instituted for the upper Grande Ronde spring Chinook program because of low abundance. Eggs collected from the program’s conventional hatchery fish were transferred to the Bonneville Hatchery where they were raised to maturity. If egg takes were low, these fish were spawned and their eggs were incorporated into the conventional hatchery program. If egg takes were met, safety net adults were released into the Grande Ronde and allowed to spawn naturally. The safety net program was scheduled to end in 2015.

The endemic spring Chinook program represents a well-coordinated effort between federal, tribal, and state agencies to supplement spring Chinook populations that were close to extinction. Abundance of spring Chinook has increased in the Grande Ronde, and few differences have been observed between hatchery and natural origin adults. Density-dependent effects, however, have been seen, smolt numbers are lower along with smolt size when parental abundance goes up. Habitat restoration is occurring, and it is hoped that this will increase the freshwater carrying capacity of the subbasin.

199800702 - Grande Ronde Supplementation Operations and Maintenance (O&M) and Monitoring and Evaluation (M&E) on Lostine River

Links to: project **and** reports

Proponent: Nez Perce Tribe

Province/subbasin: Blue Mountain/Grande Ronde

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Indirect or Potential:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

Comment:

Uncertainty #1 is being directly measured by the project.

Uncertainty #2 is being indirectly measured. Data being collected on juvenile spring Chinook in the Lostine River (e.g. numbers leaving by life-history stage) and an observed negative relationship between redd number and subsequent smolt abundance may help establish a carrying capacity value. Other parts of this uncertainty are not addressed.

Uncertainty #3 is being partially addressed as several models are being employed to predict adult returns. Other aspects of this uncertainty are not being examined.

Methods: Appropriate methods are being employed to evaluate a spring Chinook supplementation effort taking place on the Lostine River. Comparisons are being made between hatchery and natural origin juveniles (e.g., size at smolting, abundance, survival to Lower Granite Dam, and arrival timing and migration rate to Lower Granite Dam) and adults (e.g., abundance to the Lostine Weir and on Lostine River spawning grounds, size at maturation, age composition of adult recruits by broodyear, spawning ground distribution patterns, fecundity, run timing to the Lostine adult weir, and smolt-to-adult survival). Models and statistical procedures common to these types of evaluations are being used to make the comparisons. Additionally project data are being used in two models to predict future adult abundance.

Program Relevance and Project Results: This long established monitoring program was initiated to see if hatchery supplementation could be used to prevent the extirpation of spring Chinook in the Lostine River. The current objective is to see if the hatchery program is increasing the abundance of natural origin (NO) recruits returning to the river. Data acquired by the project are being used to track status and trends in Lostine River spring Chinook. Abundance of natural origin fish has increased, for the past four reporting years (2009-2012) over 500 NO adults have annually returned to the river. Evidence for density dependence at the juvenile stage appears to exist as fewer smolts are produced per redd as redd numbers increase. Few differences were seen between NO adults and hatchery adults although a significant difference was observed in age composition. Significantly more hatchery fish were maturing at age 3 (early maturation) than was found in NO fish.

Broad Applicability: Results are applicable to the Lostine River and Grande Ronde basin

Time Required: Results are being reported in a timely fashion. Monitoring of this project will be required for years to come.

199800704 - Grande Ronde Spring Chinook on Lostine/Catherine Creek/ Upper Grande Ronde Rivers

Links to: project **and** reports

Proponent: Oregon Department of Fish and Wildlife

Province/subbasin: Blue Mountain/Grande Ronde

2006 Research Plan uncertainties addressed: None

Comment:

No critical uncertainties listed in the 2006 Research Plan were addressed.

An overview of the partnerships and history of the endemic spring Chinook supplementation program occurring in Catherine Creek, Lostine River, upper Grande Ronde, and Lookingglass Creek is presented. The purpose of the project is to integrate funding from BPA with the LSRCP's endemic spring Chinook program taking place in the Grande Ronde subbasin. Results of M&E activities are reported through the LSRCP project.

Methods: Project activities focus on holding and spawning adults, rearing juveniles, plus monitoring fish health at ODFW's Lookingglass Hatchery. The project also helps evaluate natural production (redd counts) in Catherine Creek, Lostine River, and the Upper Grande Ronde River. No detailed accounts of the methods used were provided.

Program Relevance and Project Results: Short summaries of hatchery activities that took place in 2013 are provided, including a review of fish health (pathogens detected and treatment regimens used), broodstock spawning operations (pre-spawning mortality, BKD screening, pNOB values for the Catherine Creek, Lostine River and upper Grande Ronde broodstocks, types of factorial crosses implemented, and eggs obtained) and stream surveys performed. Results of M&E activities are reported through the LSRCP project.

Broad Applicability: Limited to the Grande Ronde subbasin.

Time Required: This is a routine annual report that should continue into the future.

199800703 - Grande Ronde Supplementation O&M on Catherine Creek/Upper Grande Ronde River

Links to: project **and** reports

Proponent: Umatilla Confederated Tribes (CTUIR)

Province/subbasin: Blue Mountain/Grande Ronde

2006 Research Plan uncertainties addressed: None

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- What are the impacts of weirs for adult collection on the spawning ground distribution of adult spring Chinook? Do weirs affect spawn timing and the distribution of spawning adults?
- Should the number of hatchery origin jacks allowed to spawn naturally be regulated and if so what rules should be applied?

Comment:

No uncertainties identified in the 2006 Research Plan are being addressed by the project. However, the project is examining the impact of a weir used for adult collection on the spawning ground distribution of adult spring Chinook by ascertaining whether the weir has altered spawn timing and the distribution of spawning adults. This is an uncertainty that could be examined in numerous locations throughout the Columbia River Basin.

This report provides details on the number of spring Chinook juveniles released at the Catherine Creek and Upper Grande Ronde Acclimation sites during 2014. It indicates when adult trapping at Catherine Creek and the upper Grande Ronde sites were in operation and the number of summer steelhead and spring Chinook adults caught. Information, e.g. age, origin, use (broodstock or released upstream) spawning dates, number of eggs obtained etc. are also reported. Some environmental data are also presented.

Methods: This is an Operations and Maintenance report on two fish acclimation sites, one located on Catherine Creek and the other on the upper Grand Ronde River. The report briefly describes the watersheds that the two facilities are located on and also provides a physical description of the acclimation sites. Each acclimation site has four raceways, and each raceway is designed to hold a maximum of 43,000 spring Chinook smolts. Spring Chinook from the Lookingglass hatchery operated by ODFW are transported to the sites and allowed to volitionally exit two days after being transferred. The release period lasts about 3 to 4 weeks. Any fish still remaining in a raceway are forced out. Representative samples of fish are PIT tagged at the Lookingglass Hatchery prior transfer. PIT tag detections at the Catherine Creek location are used to estimate the number of smolts leaving the facility, and they are also used to estimate migration rates and survival to Lower Granite Dam for both facilities. One release of smolts occurs at Catherine Creek while two releases are made at the Upper Grande Ronde location. Details are also provided about the weirs and handling procedures used when adult spring Chinook and summer steelhead are trapped at Catherine Creek and in the Upper Grande Ronde. A sliding scale broodstock collection approach has been used at both trapping locations to regulate the number of hatchery and natural origin fish in the broodstock and in their respective streams. The abundance of hatchery origin jacks allowed to spawn naturally is regulated at approximately 1 hatchery jack per 10 adult males. No restriction was placed on natural origin jacks. Stream surveys below each adult weir were conducted to assess impacts the weirs may be having on spawning distributions. Similar surveys are conducted above the weirs for adult abundance and hatchery/wild ratios.

Program Relevance and Project Results: This is an annual accounting of the activities that took place at the two acclimation sites. Data collected on the adults trapped and their origin could be used to track status and trends of summer steelhead and spring Chinook in Catherine Creek and the Upper Grande Ronde.

Broad Applicability: Limited to the Grande Ronde.

Time Required: This is a routine monitoring project that should continue into the future.

200708300 - Grande Ronde Supplementation Monitoring and Evaluation (M&E) on Catherine Creek/Upper Grande Ronde River

Links to: project and reports

Proponent: Umatilla Confederated Tribes (CTUIR)

Province/subbasin: Blue Mountain/Grande Ronde

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Comment:

Uncertainty #1 is being directly examined.

The project assesses the effectiveness of an effort to supplement endemic spring Chinook in Catherine Creek and in the Upper Grande Ronde River, two spring Chinook populations in the Grande Ronde subbasin. A variety of adult and juvenile salmon and stream flow data were collected and presented. However, the program did not evaluate the carrying capacity of the habitat to support natural origin spring Chinook, including density dependent limitations. This analysis would be useful since it could be used to determine how much habitat restoration is needed to rebuild the populations. Additionally, the project's M&E efforts should be integrated with habitat restoration in addition to supplementation efforts to answer the question -- can habitat restoration increase productivity and capacity, leading to increased salmon abundance that is desired?

Methods: Comparisons between natural origin spring Chinook and hatchery fish produced from a variety of treatments are being made. Juvenile traits being compared include size and condition at emigration, travel time and dates of arrival to Lower Granite Dam (LGR) and survival to LGR. Adult traits include SARs, abundance, age composition, size-at-age within the same sex, spawn timing, fecundity, and egg weights. PIT tags, CWTs, VIE tags and fin clips were used to identify hatchery fish. PIT tags were placed on natural origin recruits captured in a rotary screw trap located in the Grande Ronde making it possible to estimate their survival and travel times to LGR. Juvenile survival and travel time to LGR were calculated by using PitPro software. The Chapman modification of the Petersen method was used to estimate adult abundance in spawning areas. Parametric and non-parametric methods were employed to make comparisons. These methods are sound and typical for this type of project.

Program Relevance and Project Results: A variety of hatchery options have been implemented and evaluated. One of these was a captive brood program where natural origin juveniles were collected from Catherine Creek and the upper Grande Ronde. The juveniles were reared to maturity under hatchery conditions and artificially spawned. When their F_1 progeny had reached the smolt stage, they were released from acclimation sites into Catherine Creek or the upper Grande Ronde River. This is referred to as the captive brood strategy. Another hatchery approach (conventional) collects spring Chinook returning to adult traps and uses them as broodstock. Their progeny were placed into acclimation sites and subjected to four different types of release treatments. One called “early” allowed the fish to volitionally exit their acclimation site in early March, another called “forceout” occurred when early fish that had not volitionally left were forced out of their rearing location. This usually took place about a month after the early release had started and another group, called “late” was allowed to volitionally exit their acclimation sites beginning in mid-April. A “forceout” release was also imposed on the late group. The captive brood releases did produce adults and helped the supplementation program meet some of its early smolt release goals. Because of recent increases in abundance, captive brood adults are not being incorporated into Catherine Creek or upper Grande Ronde broodstock, and the captive brood program was terminated. A "safety net" program, however, that raises juveniles produced by conventional hatchery fish to maturity was implemented for the Upper Grande Ronde due to low abundance. As might be expected, hatchery juveniles were significantly larger at migration than natural smolts. Hatchery fish also tended to mature earlier. Natural recruits had higher SARs, but few other differences have so far been found.

Infrastructure for this evaluation (screw trap and weirs) has also allowed the project to collect basic life-history information on summer steelhead in the same area. The life history information so far obtained indicates that Catherine Creek and upper Grande Ronde summer steelhead have life histories that are consistent with other A-run fish in the Grande Ronde basin.

Status and trends information on spring Chinook and summer steelhead are being obtained by the project.

Broad Applicability: Results are applicable to the Grande Ronde subbasin.

Time Required: The latest report on this project was produced in 2008. An update on the project needs to be produced. Monitoring and evaluation of this type needs to be continued for multiple years.

199202604 - Grande Ronde Early Life History of Spring Chinook and Steelhead

Links to: project **and** reports

Proponent: Oregon Department of Fish and Wildlife

Province/subbasin: Blue Mountain/Grande Ronde

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Indirect or Potential:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

Comment:

Uncertainty #1 is being directly assessed by the project. Smolt and adult abundance is being measured and split out by natural and hatchery origin.

Uncertainty #2 is also being directly addressed by the project. Habitat restoration is occurring in the Grande Ronde and juvenile production, migration timing (life history strategy expression), size at migration, and survival of natural and supplemented fish to lower Snake River and mainstem Columbia River dams is being estimated.

Uncertainty #3 is being indirectly assessed. The project report shows that smolts per spawner and smolt size declines as adult numbers increase. Since habitat restoration is taking place in the subbasin, these relationships are likely to change, but they provide a means of measuring carrying capacity when coupled with the project's data on the effects of juvenile size and migration timing on survival. No mention is made, however, on how these relationships may be linked to the supplementation efforts occurring in the Grande Ronde. Ideally, multiple projects in a basin like the Grande Ronde should be closely linked.

Uncertainty #4 is indirectly addressed. A partnership with CHaMP was established, and efforts are being made to couple habitat characteristics with salmonid presence/absence and abundance. No mention of any efforts to produce predictive models based on their empirical data, however, were made.

The project is estimating abundance and survival, assessing migration patterns and rates, and identifying early life history strategies in spring Chinook salmon and summer steelhead from discrete populations in the Grande Ronde and Imnaha subbasins.

Methods: Five rotating screw traps were used to estimate the abundance and migration timing of juvenile spring Chinook and summer steelhead in the Grande Ronde subbasin. PIT tags were applied to migrants, and subsequent interrogations were employed to estimate the survival of migrants to Lower Granite Dam. Radio telemetry was utilized to ascertain where in the Grande Ronde early migrating juvenile spring Chinook overwintered. Adult steelhead spawner surveys were conducted by using a rotating panel design. Accuracy is assumed to be good in the annual surveys that have been completed, but precision is poor. A partnership with the CHaMP project has been established so that habitat characteristics from CHaMP sites can be coupled to the distribution and abundance of steelhead and spring Chinook parr. Snorkeling and electrofishing methods are being employed to determine presence/absence and rearing densities. Data from the CHaMP sites are also being used to explore possible small scale habitat characteristics with adult spawning areas. If relationships can be found, adult survey sites would be adjusted to increase precision. Methods for both adults and juveniles are appropriate for this type of project.

Program Relevance and Project Results: Habitat restoration and hatchery supplementation is taking place in the Grande Ronde subbasin. The project is designed to track status and trends in natural origin summer steelhead and spring Chinook to see how they respond to these management actions. Currently it appears as though there are density-dependent effects on natural fish. Mean size of spring Chinook migrants, for instance, decreases when spawner abundances rise and the number of smolts/spawner also appears to decrease as the number of spawners increases. Habitat restoration actions are being implemented in an attempt to increase productivity. The project's monitoring program should provide an objective assessment of effects related to these habitat actions and to supplementation.

Broad Applicability: Results produced from the project may help guide how habitat restoration occurs in the mid-Columbia.

Time Required: Monitoring and evaluation will need to continue for some time to fully appraise any effects of habitat restoration or supplementation.

200740400 - Spring Chinook Captive Propagation-Oregon

Links to: project **and** reports

Proponent: National Oceanic and Atmospheric Administration, Oregon Department of Fish and Wildlife

Province/subbasin: Blue Mountain/Grande Ronde

2006 Research Plan uncertainties addressed:

Direct:

- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Is it possible to establish broodstocks comprised of local fish by capturing naturally produced parr, raise them to maturity, artificially spawn them, and rear the resulting F_1 progeny to the smolt stage before liberating them from their natal streams?

Comment:

Uncertainty #1 was partially addressed. The project implemented and evaluated a captive brood and safety net program as a way to procure eggs and juveniles for its supplementation effort. This effort was started to preserve spring Chinook in the Upper Grande Ronde. In 2008 the captive brood program was terminated, and in 2015 the safety net program is scheduled to end.

The captive brood and safety net programs that were instituted as part of the endemic spring Chinook supplementation program are described. These two programs did address an artificial propagation uncertainty associated with conservation and supplementation hatcheries. Is it possible to establish broodstocks comprised of local fish by capturing naturally produced parr, raise them to maturity, artificially spawn them, and rear the resulting F_1 progeny to the smolt stage before liberating them from their natal streams?

Methods: Details on the hatchery rearing approaches that were used to produce juveniles and maturing adults are presented. Most were typical; however, it is reported that the eggs sent to Bonneville Hatchery as part of the safety net program were incubated in trays floating in 1-m tanks. Additionally the first feedings the fish received took place while the fish were still in their incubation trays. This is an unusual procedure. No explanation was provided on why it may have been implemented.

Program Relevance and Project Results: The captive brood approach produced smolts that supplemented conventional hatchery releases in the early years of the endemic spring Chinook supplementation project. Eventually as adults began to return to the supplemented streams this procedure was no longer needed and the captive brood program was stopped in 2008. However, low adult returns to the Upper Grande Ronde prompted the project to start a safety net program. In this program, 300 eyed eggs taken from the conventional hatchery program were transferred to the

Bonneville Hatchery where they were reared in freshwater to maturity. At the onset of maturity the fish were transported back to the Lookingglass Hatchery. If additional eggs were needed the fish would be artificially spawned otherwise they were released to spawn naturally. The safety net program is scheduled to end in 2015. Both programs produced adult fish and the captive brood program demonstrated that naturally produced juveniles could be used to increase smolt production from a conservation hatchery.

Broad Applicability: The captive brood and safety net approaches could be applied to depressed populations throughout the basin.

Time Required: The captive brood effort ended in 2008, and the safety net effort is scheduled to end in 2015.

Imnaha

199701501	Imnaha River Smolt Monitoring	Nez Perce Tribe
201003200	Imnaha River Steelhead Status Monitoring	Nez Perce Tribe

Summary

Several salmonid monitoring and evaluation efforts are being conducted in the Imnaha River. Results from two of them are presented here. In one, a rotary screw trap located near the mouth of the Imnaha River is being used to document the abundance, survival, and migration speed of hatchery and natural origin spring Chinook and steelhead smolts. Point estimates of abundance are made at different locations along the migration route, e.g. at the Imnaha rotary screw trap and at Lower Granite and McNary Dams. Data collected from this project provides real-time juvenile emigration information to the Fish Passage Center which is used to determine if changes in hydrosystem operations are needed to improve juvenile survival in the lower Snake River.

The second study, which began in 2011, examines the abundance, population growth, spatial distribution, and life-history expressions of summer steelhead returning to the upper Imnaha River. Fixed and floating weirs, spawning ground surveys, scale analyses, and six PIT tag arrays placed throughout the Imnaha subbasin are being used to gather this information. It was discovered that approximately 30% of the steelhead returning to the Imnaha spawn in the upper portions of the subbasin. A variety of life history strategies including overwintering locations, maturation timing, age at maturation, and years spent in salt-water prior to maturation have so far been detected in upper Imnaha summer steelhead. Data obtained from PIT tagged smolts collected from the upper Imnaha indicated that large size was correlated with high survival rates and also earlier maturation. Furthermore, significant numbers of kelts were recovered at the upper Imnaha weir sites, but kelt survival past the lower Snake River dams was estimated to be low. Steelhead in the upper Imnaha spawn and rear at higher elevations and experience different water temperatures, flow, and landscape features than steelhead spawning in lower portions of the subbasin. Although not yet demonstrated, it is hypothesized that these differences have led upper Imnaha steelhead to use dissimilar life-history strategies than conspecifics spawning in the lower portions of the river.

The methods being employed by this study were comprehensive and could be exported to other subbasins where similar questions are being asked. Additional investigations conducted on steelhead spawning in the lower Imnaha are also taking place and are coordinated with this project. The results obtained from all of the projects should provide definitive information on the distribution, abundance, and population growth of Imnaha summer steelhead.

199701501 - Imnaha River Smolt Monitoring

Links to: project **and** reports

Proponent: Nez Perce Tribe

Province/subbasin: Blue Mountain/Imnaha

2006 Research Plan uncertainties addressed:

Direct:

- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?

Comment:

Uncertainty #1 is partly addressed. SAR estimates are made on PIT tagged steelhead and spring Chinook. No SAR estimates were made for transported fish. The possible effects of spill operations on SARs could be examined, and it might also be possible to assess how dam passage and spill influences adult migration rate, straying, and pre-spawn mortality. However, these issues were not mentioned.

Regarding Uncertainty #2, several of the questions posed in this uncertainty are being addressed. For example the project is directly measuring the effects of flow and spill on survival of juvenile salmonids emigrating from the Imnaha to Lower Granite and McNary Dams. Additionally species and life-history effects on juvenile survival and migration timing are being examined. Other aspects of this uncertainty are not being examined.

The project provides the Fish Passage Center (FPC) with tributary specific emigration data on spring Chinook and steelhead smolts originating from the Imnaha River. The data provided to the FPC is used for in-season operational decisions relative to flow and spill management, particularly during periods when spill is being provided to improve smolt passage.

Methods: A rotary screw trap located near the mouth of the Imnaha River plus PIT tags are being used to measure survival, abundance, and migration speed on Imnaha hatchery and natural spring Chinook and steelhead juveniles. Computer software (e.g. the Gauss Program with a Bailey trap efficiency estimation method) is being used to make point estimates of juvenile abundance with 95% Confidence Intervals for hatchery and natural spring Chinook and steelhead at different points along their migration route (e.g. at the Imnaha trap, Lower Granite Dam [LGR] and McNary Dam). Kolmogorov-Smirnov tests were employed to compare migration speed of hatchery and natural-origin juveniles in both species from the Imnaha trap to LGR, plus regression analyses were used to examine relationships between river flow and juvenile migration speed. Comprehensive life-stage specific survival estimates for hatchery juveniles while they emigrated down the Imnaha were performed to compare different rearing and release strategies. Additionally PIT tag interrogations on adults returning to LGR were used to estimate smolt-to-adult survival rates on hatchery and natural-origin fish. The methods appear to be appropriate for this type of monitoring and evaluation project.

Program Relevance and Project Results: The project is supplying real-time juvenile spring Chinook and steelhead emigration data to the Fish Passage Center, so that managers can make decisions related to flow and spill operations in the lower Snake River. Consequently, the project is helping to determine how or if changes in hydrosystem operations influence juvenile survival. Additionally, survival, emigration speed, and biological attributes of Imnaha River natural- and hatchery-origin spring Chinook and steelhead are being compared as part of the LSRCP. Results of these analyses may inform future hatchery operations for these species in the Imnaha and possibly in other Snake River tributary subbasins. Abundance data collected on juveniles and adult spring Chinook and steelhead are being used to track status and trends in these populations.

Broad Applicability: Results are applicable to the Imnaha River basin and in the lower Snake River.

Time Required: This monitoring program has been ongoing for 19 years. The value of this data set will continue to increase over time and should continue into the foreseeable future.

201003200 - Imnaha River Steelhead Status Monitoring

Links to: project and reports

Proponent: Nez Perce Tribe

Province/subbasin: Blue Mountain/Imnaha

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- What is the status and viability of ESA-listed populations? Specifically for ESA-listed steelhead in the Imnaha River subbasin, is there sufficient information on the adults to manage and recover the population?

Comment:

This project has monitored abundance and spatial distribution, and collected life history information, on steelhead (*Oncorhynchus mykiss*) from the Imnaha River starting in 2011. The critical uncertainty being addressed by this project is the lack of adult steelhead information for the Imnaha subbasin. It is also unknown whether and how steelhead spawning in the upper Imnaha differ from steelhead spawning in the lower Imnaha. Due to its short history, the annual recent report covers only the second year of monitoring. The overall quality of this report on status and trend M&E is excellent.

General Comment: The project collected life history information and monitored abundance and spatial distribution of steelhead (*Oncorhynchus mykiss*) from the Imnaha River starting in 2011. Due to its short history, the annual recent report covers only the second year of monitoring.

Methods: Standard methods are employed to evaluate steelhead populations (e.g., PIT tags, scale reading, weirs, and visual surveys of redds).

Program Relevance and Project Results: This project is highly relevant since Imnaha River steelhead are an ESA-listed population. Being only the second year of a long term monitoring effort, no trends are evident.

Broad Applicability: Appears to be a good model for other subbasins with ESA-listed populations.

Time Required: At least a decade for monitoring will be needed to establish trends in abundance, population growth, spatial distribution, and life history characteristics, and how they respond to environmental influences and human-related pressures.

Clearwater

198335003	Nez Perce Tribal Hatchery Monitoring and Evaluation (M&E)	Nez Perce Tribe
201201300	Snake River Fall Chinook Monitoring and Evaluation	Nez Perce Tribe, Washington Department of Fish and Wildlife (WDFW)
201005700	B-run steelhead supplementation effectiveness research	Idaho Department of Fish and Game (IDFG), Nez Perce Tribe

Summary

The Clearwater River M&E projects are collecting good information, but the information has not been synthesized to address critical uncertainties. B-run steelhead and fall Chinook projects are relatively new.

198335003 - Nez Perce Tribal Hatchery Monitoring and Evaluation (M&E)

Links to: project **and** reports

Proponent: Nez Perce Tribe

Province/subbasin: Mountain Snake/Clearwater

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Climate Change: Can integrated ecological monitoring be used to determine how climate change simultaneously affects fish and wildlife and the freshwater, estuarine, ocean, and terrestrial habitats and ecosystems that sustain them?
- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or

temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Fish Propagation: What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles and from harvest in fisheries targeting hatchery-origin adults?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?

Comment:

The long-term goal of this project is to monitor and evaluate results of the Nez Perce Tribal Hatchery (spring Chinook and fall Chinook) in the Clearwater River Subbasin so that operations can be adaptively managed to optimize hatchery and natural production, sustain harvest, and minimize deleterious ecological effects. This project touches on a number of critical uncertainties (as noted above) and contributes important data, but it seems unlikely to resolve those uncertainties without further synthesis or integration with other experimental studies. Therefore, at this time, the project has yet to directly address any of the uncertainties shown above.

Methods: Monitoring methods seem appropriate for examining supplementation of spring Chinook in three tributaries of the Clearwater River and supplementation of fall Chinook via release at multiple acclimation sites. A variety of appropriate performance metrics were reported. An evaluation of performance measures to assess overall progress (or reasons for uncertainty about progress) towards achieving objectives seems warranted.

Program relevance and brief summary of findings:

Status and trends monitoring: This project is designed to monitor and evaluate hatchery performance in increasing distribution, abundance, and harvest of hatchery and natural Chinook salmon populations in the Clearwater River Subbasin. Outcomes and trends in six treatment streams will eventually be compared to those in similar non-treatment (reference) streams and other hatchery programs to distinguish treatment effects from the effects of environmental variation. In addition, the M&E Program is reportedly designed to provide information on the capacity (density dependence) of the natural environment to support Chinook salmon production, give early warning of adverse effects caused by the project on resident biota, and track trends in environmental quality, management, and policy that may affect project success.

Performance measures are defined quantitatively for abundance, productivity, distribution, genetic and life history diversity. These measures are derived from data collected during juvenile and adult monitoring activities, and most are listed with considerable detail in the annual reports.

The long-term goal and objectives are relevant to the fish propagation uncertainties, but the annual reports do not attempt to address these long-term objectives, including carrying capacity (density dependence) and effects on resident biota. Rather, the annual report presents data collected to date that might eventually be used to evaluate these important objectives. Additional years of monitoring are needed before the objectives and uncertainties can be addressed. The M&E project reportedly examines the performance and status of hatchery and natural fish, effects of fish propagation on non-targeted fish populations (but this was not apparent in the annual report) and sustainability of harvest, and findings are communicated to enable adaptive management of the Nez Perce Tribal Hatchery (NPTH). Based on the annual report, there does not appear to have been much synthesis or interpretation of the performance measures to assess overall success at achieving the objectives. A higher level synthesis report is warranted, especially in light of ISRP (2010) concerns that SAR targets may be unrealistic.

The monitoring effort is long term (since 1988 for Clearwater River, since 2003 for NPTH fish) for Chinook salmon populations at the subbasin scale. No habitat restoration was described other than removal of the large dam on the Clearwater River that blocked adult migration. The eventual synthesis of data should address responses to habitat actions in the region.

Broad Applicability: The long-term objectives of the project have broad application, but the report does not attempt to address these objectives at this time.

Time Required: Data reporting is up-to-date, and previous years of data were included in tables. It will reportedly take at least 10-15 years before the project may transition to Phase 3: a sustainable natural population that can support harvest. It is unclear when the long-term objectives are projected to be achieved.

201201300 - Snake River Fall Chinook Monitoring and Evaluation

Links to: project **and** reports

Proponent: Nez Perce Tribe, Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Middle Snake/Snake Lower Middle

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?

Comment:

This project began in 2013, and the first of several annual reports was released in May 2015. The goal is to understand the behavior and spatial distribution of returning adults originating from yearling and subyearling fall Chinook releases that were made from a variety of on-station and off-station sites in the Snake River. The project is evaluating whether the homing fidelity is sufficient to achieve 10% or less hatchery origin spawners in any one spawning aggregation. This project addresses the uncertainty that subyearling hatchery fall Chinook can home back to their release area (including fallback at Lower Granite Dam) and therefore potentially minimize pHOS on the spawning grounds. The project also has the potential to evaluate whether hatchery fish are spawning in low quality habitat, thereby reducing their reproductive success.

Methods: Fall Chinook adults that were PIT tagged as juveniles are being collected at Lower Granite Dam. PIT tag data are used to identify the smolt release location of each adult. Radio tags are applied to the collected adults, who are tracked throughout the Snake River to evaluate whether the fish return to areas close to their release locations. Methods are generally sound, but statistical analyses should be augmented with spatial methods so that homing fidelity to smolt release locations can be determined.

***Program relevance and brief summary of findings*:** Limited results for this research project are available at this time, as the study began in 2013.

Broad Applicability: The study may have applicability for other hatcheries in the Snake River basin and other fall Chinook hatcheries in the Columbia Basin.

Time Required: The project will track the distribution of hatchery-origin adult fall Chinook originating from known smolt release areas for 5 years (2013 – 2017). Data analyses covering all 5 years will occur in 2018. This is a reasonable timeline. Initial findings from 2013 and 2014 were reported in early 2015.

201005700 - B-run steelhead supplementation effectiveness research

Links to: project **and** reports

Proponent: Idaho Department of Fish and Game (IDFG), Nez Perce Tribe

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Comment:

This new project (started in late 2011) will monitor the effectiveness of B-run steelhead hatchery (supplementation) in the Clearwater River Subbasin. Short term productivity will be assessed through Relative Reproductive Success (RRS) in Lolo Creek. Comparative performance of conventional and supplemental production strategies will be evaluated in the South Fork Clearwater River. The emphasis on uncertainties related to genetic adaptation during reintroduction and on testing techniques for reintroduction is being indirectly addressed by the three fish propagation uncertainties.

No reports on the project have been downloaded to Pisces. Information for this project was obtained from the Project Summary and Proposal Summary plus the ISRP review of LSRCP steelhead report (ISRP 2013-03) and a project summary posted on the Nez Perce Tribal web page. These are descriptive accounts of the kinds of questions the project is designed to answer, their significance to management and the methods that will be used. No data generated from the project were in these accounts.

Methods: An earlier review by the ISRP (Oct 2010) stated that the methods proposed by the project appeared to be appropriate. An important component of the project was the construction and operation of a permanent weir on Lolo Creek. The weir would be used for counts of adult and juvenile steelhead entering and leaving Lolo Creek. Counts at the weir were intended to validate adult counts of PIT-tagged steelhead obtained from an upstream PIT tag detection array put in place by ISEMP. However, it does not appear that the weir has been built, and plans for its construction and installation may have been terminated. Apparently, a temporary or seasonal weir may be used instead. It is not possible to comment on the accuracy or precision of project data as none have yet been reported.

Program Relevance and Project Results: The project has the potential to address a number of significant uncertainties (*see* list above). Briefly, what prompted the study was a significant change in the number and kind of hatchery steelhead that were planted into the South Fork Clearwater River (SFCR) and into Lolo Creek. Prior to a change in the U.S. v. Oregon Agreement, 50,000 hatchery steelhead smolts were released into Lolo Creek and another 800,000 were annually planted into the SFCR. The new agreement calls for releasing 200,000 hatchery steelhead into Lolo Creek, and 1.17 million into SFCR. All hatchery steelhead released into Lolo Creek will have Coded-Wire Tags (CWT), but their adipose fins will not be clipped. Similarly, 330,000 hatchery steelhead released into the SFCR will also have CWTs and intact adipose fins. The remaining 840,000 hatchery fish released into the SFCR will possess CWTs, but their adipose fins will be clipped. The hatchery smolts with intact adipose fins are referred to as “Supplementation” fish while those that have CWTs and clipped adipose fins are called “Conventional.”

An effort was begun in 2010 to incorporate or integrate locally caught natural origin adults (NO) into the Supplementation broodstock—hence the main difference between them and Conventional smolts. The project was designed to answer the following six questions: (a) is there a velocity barrier to adult steelhead in the Clearwater River downstream of where hatchery smolts are being released? (b) Will incorporating local NO fish into the broodstock increase the relative reproductive fitness of hatchery origin females spawning in the wild? (c) Will the wider use of acclimation sites and the ability to modify release sites and numbers of smolts released increase adult returns? (d) What impact does supplementation have on natural population productivity? (e) Is there a difference in SAR values between Conventional and Supplementation smolts? And (f) Does the supplementation strategy influence the spatial distribution of adults above Lower Granite Dam?

If carried out as planned the project will collect status and trends data on Lolo Creek (stream scale) and South Fork Clearwater River (watershed scale) steelhead.

High Level Indicators that are expected to be covered include abundance and genetic diversity.

Broad Applicability: Results of the project will be important for B-run steelhead management and may also supply information about the value of incorporating local broodstock into hatchery programs for steelhead.

Time Required: No results have been reported even though the project has been ongoing for at least five years. The project proposal states that three complete brood cycles or 15 years will be required before final results are available. ISRP (2010) noted that the timeline might be shorter if it was clear that the supplementation effort was not approaching its objectives.

Idaho Supplementation Studies

199005500	Idaho Steelhead Monitoring and Evaluation (M&E) Studies	Idaho Department of Fish and Game (IDFG)
198909800	Salmon Studies in Idaho Rivers	Idaho Department of Fish and Game (IDFG), Nez Perce Tribe, Shoshone-Bannock Tribes, US Fish and Wildlife Service (USFWS)
199107300	Idaho Natural Production Monitoring and Evaluation (M&E)	Idaho Department of Fish and Game (IDFG)
199703000	Secesh chinook & Joseph Creek steelhead abundance monitoring	Nez Perce Tribe

Summary

These four Idaho studies primarily monitor Chinook and steelhead populations in Idaho Rivers, including the contributions of supplemented hatchery fish. Each project directly addresses the new uncertainty that involves collection of viable salmonid population criteria:

- What is the status and viability of ESA-listed populations?

Collectively, the four Idaho projects are addressing the following critical uncertainties. However, additional data collection, synthesis, and evaluation are needed before the uncertainties can be fully addressed. Additional uncertainties that the projects might also address are shown along with a brief description of each project.

- What are the factors that control wild salmon production and productivity?
- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management

rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles and from harvest in fisheries targeting hatchery-origin adults?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

199005500 - Idaho Steelhead Monitoring and Evaluation (M&E) Studies

Links to: project **and** reports

Proponent: Idaho Department of Fish and Game (IDFG)

Province/subbasin: Mountain Snake/Clearwater

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?

Indirect or Potential:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Harvest: How can the multiple ecological benefits that salmon provide to the watersheds where they spawn (e.g., provision of a food resource for wildlife and a nutrient source for streams and riparian areas) be incorporated effectively into procedures for establishing escapement goals?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?

- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- What is the status and viability of ESA-listed populations?

Comment:

Performance of ESA-listed steelhead population units in the Clearwater and Salmon subbasins is evaluated in terms of population growth rate, abundance, genetic and life history diversity, and spatial distribution within the ESU. The project directly addresses the additional uncertainty regarding status and viability of ESA-listed steelhead, and it also directly examines density dependence (carrying capacity) of a few populations. The project indirectly contributes to the other uncertainties listed above; additional analyses are needed.

Methods: Monitoring and evaluation methods deemed appropriate by ISRP (2010) are being used. At least one peer-reviewed publication resulted from this effort.

Program relevance and brief summary of findings: Status and Trend M&E: This project provides data needed for determining migration timing and life histories of steelhead, determining population specific smolt-to-adult return rates (SAR) in index streams, comparing SAR's of Idaho populations with other downriver stocks, collecting tributary specific adult and juvenile abundance data, evaluating downstream passage through the hydrosystem, developing stock specific productivity metrics (juveniles and smolts per female), and characterizing the steelhead stock structure within Idaho. The project has contributed a major portion of the current genetic baseline for Snake River steelhead. Water temperature was also recorded at 23 locations in the Clearwater and Salmon Rivers, posted on-line but not analyzed.

The ISRP (2010) commented "Because the proposal lacks a comprehensive explanation of steelhead monitoring in Idaho, the specific role ISMES contributes is difficult to ascertain. The ISRP has no reason to believe the monitoring is not essential, but the need for monitoring should be made clearer in the proposal."

A Published study by Copeland et al. (2014) documents how density dependent dispersive life histories (Downstream Rearing [DSR] vs. Natal Reach Rearing [NRR] types of Chinook) are essential to achieve the full productive potential of migratory stream fish populations, and underscores the importance of considering downstream rearing habitat in habitat restoration plans.

Steelhead productivity was low when spawner abundance was high, providing evidence of density-dependence in the last two decades.

Broad Applicability: A three-tiered approach to monitoring helps to ensure that results are broadly applicable to the Clearwater and Salmon subbasins, and likely comparable subbasins elsewhere: (1) Overall Discrete Population Segment (DPS) status and trend is assessed by sampling adults and smolts at Lower Granite Dam, and genetic stock identification methods are used to assign proportions of the aggregate estimates to major population groups and, in some cases, populations. (2) Intensive "fish in, fish out" monitoring with suitable sampling infrastructure (e.g., a weir and rotary screw trap) is directed at selected populations to support life cycle modeling, leading to a mechanistic understanding of population dynamics. And (3) Extensive monitoring efforts without sampling infrastructure are directed at the remaining populations.

Time Required: Reports are timely. The project implementation began in 1993. Long-term monitoring is needed to track ESA-listed steelhead viability. Therefore, the project will likely continue into the foreseeable future.

198909800 - Salmon Studies in Idaho Rivers

Links to: project **and** reports

Proponent: Idaho Department of Fish and Game (IDFG), Nez Perce Tribe, Shoshone-Bannock Tribes, US Fish and Wildlife Service (USFWS)

Province/subbasin: Mountain Snake/Salmon

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles and from harvest in fisheries targeting hatchery-origin adults?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Indirect or Potential:

- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?
- Harvest: How can the multiple ecological benefits that salmon provide to the watersheds where they spawn (e.g., provision of a food resource for wildlife and a nutrient source for streams and riparian areas) be incorporated effectively into procedures for establishing escapement goals?

Comment:

The Idaho Supplementation Studies (ISS) project was implemented in 1992 to address the critical uncertainty involving the benefits and risks of using hatchery supplementation to increase natural production of spring/summer Chinook salmon in Idaho (i.e., effects on productivity, persistence, establishment, and advantages of localized broodstocks). The project has operated over three study phases. The second phase (supplementation) ended in 2007 (the last adult supplementation fish returned in 2007). Beginning with brood year 2008, the ISS project entered its final phase of evaluating post-supplementation population responses.

Project objectives are (1) monitor and evaluate the effects of supplementation on presmolt and smolt numbers and spawning escapement of naturally produced Chinook Salmon; (2) monitor and evaluate changes in the productivity and genetic composition of naturally spawning target and adjacent populations following supplementation activities; (3) determine which supplementation strategies (broodstock and release stage) provide the most rapid and successful response in natural production without adverse effects on productivity; and (4) develop supplementation recommendations.

This project directly addresses each of the fish propagation uncertainties listed above, but detailed data syntheses are needed. The data may be used to examine the uncertainty regarding population structure and diversity.

Methods: Monitoring and evaluation methods seem appropriate. Data collection includes (1) installing and operating screw traps, (2) adult collection and marking at program weirs, (3) redd and carcass surveys, (4) PIT tagging juvenile migrants, (5) collection of DNA from adult and juvenile Chinook salmon in study streams, (6). Data analyses include (a) adult escapement estimates, (b) juvenile survival estimates to Lower Granite dam, (c) juvenile production estimates, and (d) DNA from adult and juvenile Chinook salmon for parentage analysis and genetic monitoring.

The ISRP (2010) commended the study's statistical design but cautioned *"It is still not clear whether the ISS will yield data that can be analyzed to answer questions about the efficacy of supplementation. The primary challenge is the quality (precision) of adult abundance data that can be derived from redd count and carcass inspection in study streams that lack interrogation weirs. Even on streams that have weirs, estimating weir efficiency and adjusting data may be necessary.*"

Program relevance and brief summary of findings:

Status and trends monitoring and research: The annual report provides valuable data that will be used to evaluate the overall project goals and objectives. This synthesis, however, was not presented in the annual data report. The project team has published several studies in recent years involving life history diversity and density dependence and their implications for habitat restoration and supplementation.

The study by Walters et al. (2013; Ecology of Freshwater Fish 22:508-519) concluded that the ubiquity of density dependence for these threatened populations is alarming because it implies recovery may be difficult without major habitat changes. Overwinter mortality, spatial clustering of redds, and limited resource availability were identified as potentially important limiting factors contributing to density dependence.

An overall evaluation of the effects of supplementation has not yet been reported, as post supplementation data are still being collected.

Broad Applicability: In 2010, the ISRP concluded that justification for this project is well documented. The project has many links and relations—and large implications—for many other projects in the basin.

Sixteen streams have received supplementation treatments and 14 are un-supplemented controls. The project's experimental design allows analyses at three spatial scales. The first and main level of evaluation is large-scale population production and productivity studies designed to provide relatively generic inferences state wide. The second level uses the same study streams as individual "case histories" to evaluate specific supplementation programs (i.e., individual hatchery programs), although inferences at this level are limited to only descriptive assessments. The third level represents small-scale studies designed to address specific hypotheses concerning the mechanism of supplementation.

Time Required: This is a long-term research initiative (it began in 1992) that uses a multi-phased approach to evaluate supplementation. In Phase I, local adult returns were collected to develop supplementation broodstock. In Phase II (treatment phase), the returning supplementation adults were used to augment natural reproduction in treatment streams. In Phase III, or the evaluation phase, supplementation treatments will be terminated, but production and productivity will continue to be monitored in both treatment and control populations for one Chinook salmon generation (i.e., five years). Determining population responses after supplementation ceases will provide valuable insights into the long-term effects of supplementation. Currently, the project is transitioning between Phase II and III.

199107300 - Idaho Natural Production Monitoring and Evaluation (M&E)

Links to: project **and** reports

Proponent: Idaho Department of Fish and Game (IDFG)

Province/subbasin: Mountain Snake/Salmon

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?

Indirect or Potential

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- What is the status and viability of ESA-listed populations?
- What are the factors that control wild salmon production and productivity?

Comment:

The Idaho Natural Production Monitoring and Evaluation Project (INPMEP) addresses the critical uncertainty to understand and predict the population dynamics and associated controlling factors of wild and natural anadromous salmonids that spawn upstream from Lower Granite Dam (LGR). This is long-term research that originated in the 1980s to determine effectiveness of habitat mitigation for steelhead and spring/summer Chinook in Idaho. This project assesses population specific characteristics, abundance, survival, productivity, life history, spatial structure, and density dependence. The fraction of hatchery origin fish on the spawning grounds was taken into consideration when these values were calculated.

The project directly addresses two additional uncertainties regarding the status of ESA populations and factors that affect those populations, although analyses that link habitat restoration to salmon viability have not been undertaken. The project also directly addresses carrying capacity (density dependence) and researchers have noted the importance of downstream habitat for population recovery. The project might provide data to inform other listed uncertainties.

Methods: ISRP (2010) noted that "the proposal employs competent methods, adequate metrics, and qualified people."

Program relevance and brief summary of findings:

Status and trends monitoring: The goal is to provide information for monitoring the status of Idaho's wild Chinook salmon and steelhead populations with respect to viable salmonid population (VSP) criteria. The project has four objectives: (1) Estimate 2012 adult abundance and population origin of returning wild adult Chinook salmon passing LGR; (2) Estimate population-specific abundance, hatchery fraction, and stock composition of wild Chinook salmon from information obtained on the spawning grounds in the Salmon River and Clearwater River subbasins; (3) Estimate life cycle survival and the freshwater productivity of the Snake River Chinook salmon ESU; and (4) Estimate the distribution and abundance of wild Chinook salmon and steelhead parr in tributaries of the Salmon River and Clearwater River subbasins.

The abundance of wild adult spawning spring-summer Chinook salmon in Idaho continues to be very low compared to historical estimates. Even though vast areas of Chinook spawning habitat are available, the low abundance of these fish has caused their spawning distributions to be patchy and not well dispersed over the available habitat. Additionally, stock-recruit analysis has revealed that current Chinook smolt production is limited by density-dependent factors.

The project documented a variety of growth and life history patterns in precocious spring–summer Chinook salmon in the Snake River basin as inferred from scale patterns, and defined precocious strategies as mature parr, minjacks, and jacks. It also demonstrated that minijacks are capable of successfully traveling from Idaho to the Columbia River estuary and back (a minimum of 2,600 river kilometers from the Pahsimeroi River) within approximately 4 months.

The annual report provides valuable data that will be used to evaluate the overall goals and objectives, but relatively little synthesis was presented in the annual report. The project team has published several important studies in recent years involving life history diversity and density dependence and their implications for habitat restoration and supplementation.

Broad Applicability: The RM&E project is applicable to the entire Snake River basin. Studies have been published. Insights about life history diversity and population dynamics probably apply to other comparable subbasins in the Columbia.

Time Required: This is a long-term research, monitoring and evaluation initiative that is needed to understand factors affecting the viability of ESA-listed spring/summer Chinook and steelhead.

199703000 - Secesh Chinook & Joseph Creek steelhead abundance monitoring

Links to: project **and** reports

Proponent: Nez Perce Tribe

Province/subbasin: Mountain Snake/Salmon

2006 Research Plan uncertainties addressed:

Indirect or Potential:

Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- What is the status and viability of ESA-listed populations?

Comment:

The Secesh and Joseph Creek monitoring project collects data for long-term monitoring of trends in escapements and productivity of wild Chinook salmon and steelhead. This information is used for resource management and recovery monitoring of threatened species. Wild Chinook salmon escapements are monitored in the Secesh River, and the information provides reference data to evaluate supplementation activities in other streams. This project contributes information to address uncertainties involving abundance dynamics of spawning wild salmon and steelhead. It also serves as a control for supplementation studies in the Snake River basin. Therefore, the project contributes information that is being used to answer a number of uncertainties, but it does not directly address those uncertainties.

Methods: The ISRP (2010) concluded that the project met scientific review criteria. DIDSON sonar counts of adult Chinook were verified with visual counts in 2014.

Program relevance and brief summary of findings:

Status and Trend M&E: The Secesh River supports an un-supplemented spring/summer Chinook population in the South Fork Salmon River and is a reference stream for three ongoing supplementation evaluation programs. It is the only stream in the Snake River basin where monitoring of natural origin Chinook salmon escapement occurs absent a hatchery supplementation program. Data collected on Secesh River Chinook are also used for monitoring population status, assessing productivity (progeny-per-parent ratios) and migration timing. Results indicate that the Secesh Chinook population is still not viable according to Interior Columbia River Basin Technical Recovery Team (ICTRT) criteria.

Escapements of Chinook salmon to the Secesh River ranged from 206 salmon in 2006 to 1,405 salmon in 2014. The 10 year geometric mean spawner abundance in the Secesh River is 671 salmon. Hatchery fraction in this un-supplemented watershed ranged from 0.6% to 8.9%. The Nez Perce Tribe established a sustainable escapement objective for salmon management in the Secesh River of 5,400 fish. This project addressed the critical uncertainty of documenting hatchery fish straying into a wild fish population.

Joseph Creek supports a non-supplemented, A-run summer steelhead population that was identified as a priority population for high precision assessment under the ESA. The current project validates redd counts with mark-recapture estimates derived from a weir and PIT tag arrays and provides tissue samples for genetic studies. The project also addresses the critical uncertainty of documenting straying by hatchery fish; between 2011 and 2013, 2.2-3.8% of spawners in Joseph Creek were hatchery strays, most of the strays originated from the Tucannon River.

Natural origin steelhead escapement from 2011 to 2013 has ranged from 1,701 to 1,919 fish compared with the spawner escapement target of 500 steelhead. In 2014, one out of 123 steelhead (0.8%) was determined to be a repeat spawner based on scale analysis. Estimated returns to Joseph Creek represented 3.5% to 5.5% of the total estimated Snake River basin natural origin steelhead escapement observed at Lower Granite Dam in 2011 and 2012, respectively. The population meets the ICTRT's viability criteria for abundance and productivity.

The project provides information that could be used to address uncertainties about density dependence and carrying capacity.

Broad Applicability: Results pertain to Chinook and steelhead within the Snake River basin. Insights about life history diversity and population dynamics may apply to other comparable subbasins in the Columbia.

Time Required: Reporting of results is timely. This is a long-term M&E project of native Chinook and steelhead.

Salmon River

199604300	Johnson Creek Artificial Propagation Enhancement	Nez Perce Tribe
200740300	Spring Chinook Captive Propagation-Idaho	Idaho Department of Fish and Game (IDFG)
200890500	Supplementation Projects	Shoshone-Bannock Tribes

Summary

Two projects in the Salmon River are directly addressing the critical uncertainty:

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

The Johnson Creek project is assessing the reproductive success of hatchery Chinook salmon (produced from 100% natural broodstock) spawning in the river compared with natural origin fish. The captive broodstock project has demonstrated that it is possible to rear spring Chinook in a hatchery and produce fish that can successfully spawn and produce progeny in the wild. The captive broodstock approach is an important tool for recovering severely depleted populations, whereas the supplementation approach targets populations that are viable but overall abundance is lower than desired. A third project is attempting to supplement a highly degraded river with hatchery Chinook salmon and steelhead while habitat restoration projects are underway, but findings have not been reported since 2010. Overall progress in the Salmon subbasin is good but additional questions remain about the benefits of supplementation.

199604300 - Johnson Creek Artificial Propagation Enhancement

Links to: project **and** reports

Proponent: Nez Perce Tribe

Province/subbasin: Mountain Snake/Salmon

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Indirect or Potential:

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?

Comment:

The Johnson Creek Artificial Propagation and Enhancement (JCAPE) project is a small-scale supplementation initiative integrated with a monitoring and evaluation program that is designed to increase survival of a weak but recoverable spawning aggregate of summer Chinook salmon. Supplementation under this project is planned for a minimum of 5 full salmon generations or 25 years. Annual releases of artificially reared progeny from 100% wild origin adults were initiated in 2000. Smolt releases (~110,000 per yr) represent the only ongoing spring/summer Chinook salmon artificial propagation program in the Salmon River subbasin specifically designated as "supplementation." Project annual reports provide basic data that appear to support, in part, a peer-reviewed paper by Hess et al. (2012) that addressed the critical uncertainty of whether hatchery fish spawning in the wild have equal or lower reproductive success than the natural origin adults. Many more species-specific studies of this type are needed before conclusions can be drawn.

The JCAPE project directly addresses the critical uncertainty regarding the demographic benefit of supplementation using a broodstock that is 100% natural origin fish. The project will contribute to the other uncertainty that involves the level of supplementation, brood stock composition, and spawning composition.

Methods: In 2010, the ISRP concluded: "The ISRP believes that natural-origin abundance trends in Johnson Creek as a response to a supplementation treatment must be interpreted by reference to an unsupplemented reference location. The Sesech River is proposed by the proponent. The proposed expansion of the Johnson Creek project and facilities needs to be reviewed through the Council's Three-Step process. Expansion has the potential to decrease natural adult abundance by removing adults for hatchery production, and the potential to increase density dependent effects on juvenile survival and life-history/behavior by addition of juveniles beyond the stream's carrying capacity."

Program Relevance and Project Results: Project reports compare a variety of metrics associated with smolt releases from the supplementation hatchery versus production of natural origin spawners, which includes hatchery adults spawning in the river. These basic data appear to support the peer-reviewed publication by Hess et al. (2012), which addressed the critical uncertainty of whether hatchery fish spawning in the wild have equal or lower reproductive success than the natural origin adults.

Broad Applicability: The peer-reviewed publication by Hess et al. has broad applicability. More studies of this type and continued monitoring and evaluation of the Johnson Creek population, however, are needed before conclusions can be reached on whether hatchery fish (and their progeny) and natural origin fish have comparable reproductive success when spawning in nature. This study tested the unique case where hatchery broodstock was 100% natural origin fish, which is the same approach used in the Yakima River supplementation study reported by Fast et al. (2015).

Time Required: Supplementation under this project is planned for a minimum of 5 full salmon generations or 25 years.

200740300 - Spring Chinook Captive Propagation-Idaho

Links to: project **and** reports

Proponent: Idaho Department of Fish and Game (IDFG)

Province/subbasin: Mountain Snake/Salmon

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Comment:

The ultimate goal of the Idaho Department of Fish and Game (IDFG) Captive Rearing Program of Salmon River Spring Chinook Salmon is to maintain a minimum number of adults spawning in specific target streams annually. To achieve this goal, the program is testing the efficacy of the captive rearing conservation approach, a critical uncertainty for salmon recovery when abundances are extremely low. Project activities are divided into two parts: 1) hatchery propagation and 2) spawning performance monitoring and evaluation. The success of the project depends on developing culture techniques to produce fish with proper behavioral, morphological, physiological characteristics to successfully interact and breed with wild individuals. Field monitoring is used to document behavioral interactions, spawn timing, success of redds spawned by captive-reared individuals, and to determine if changes in culture technique results in desired changes in reproductive behavior or performance. In addition, an important component of this program is to document successful production (juveniles and adults) from captive adult spawning events. The project addressed the critical uncertainty and demonstrated that the captive brood stock approach can produce adult Chinook salmon that spawn in streams and produce progeny that return as adults. Adult return per spawner was low for naturally spawning captive brood parents (~0.14), which was reportedly similar to nearby hatchery Chinook spawning in the wild (0.14), but much lower than the natural origin Chinook in the East Fork Salmon River (~2.2). Nevertheless, the captive brood project provides a means to rescue depleted salmon populations by increasing lifetime survival within the hatchery environment.

This project directly addresses the critical uncertainty regarding the demographic benefit of supplementation using a captive brood stock approach to rescue severely depleted populations. Many questions remain.

Methods: The 2010 ISRP review stated: “The ISRP believes there are several critical challenges to using this technology as a salmon recovery strategy. One is deciding at what point (the trigger) in the decline in population abundance should captive propagation begin? A second is to identify the time needed to get infrastructure in place to make a difference in the population’s recovery trajectory. A third would address what geographic scale of intervention is required to support the metapopulation structure of an ESU with 31 populations. If all populations are in serious decline, how many need to be incorporated into captive propagation? If only a few are in serious decline, is intervention justified? The joint summary report should complete the adaptive management for the project and identify the broader basinwide implications of the research, which will have been conducted for nearly two decades.”

Program Relevance and Project Results: See above

Broad Applicability: Applicability is broad.

Time Required: The project will be completed in 2015, including a project completion report.

200890500 - Supplementation Projects

Links to: project **and** reports

Proponent: Shoshone-Bannock Tribes

Province/subbasin: Upper Snake/Snake Upper

2006 Research Plan uncertainties addressed:

Indirect or Potential

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Comment:

The Anadromous Fish Program (AFP) is responsible for implementing five fishery restoration projects in the Salmon River subbasin to meet Tribal harvest, culture, and conservation objectives. In 2011, the ISRP reviewed the project proposal and ongoing efforts and requested a response to a number of technical issues regarding the supplementation effort http://www.nwcouncil.org/media/33273/isrp2011_16.pdf). The project appears to have received funding ($0.5 million per year through 2014). However, no project report is available since 2010. In 2010, information on hatchery Chinook smolts, steelhead fry and hatchery adults released into the watershed and the presence of natural adult spawners in the river were reported. The project may eventually contribute to the uncertainty associated with hatchery supplementation in a degraded watershed that had few, if any, natural production prior to restoration.

Methods: In 2011, the ISRP reviewed the project proposal and ongoing efforts and requested a response to a number of technical issues regarding supplementation.

Program Relevance and Project Results: The project appears to have received funding ($0.5 million per year through 2014). However, no project report is available since 2010.

Broad Applicability: Limited to the Yankee Fork.

Time Required: Uncertain. Successful supplementation will depend on the complementary project to restore severely degraded habitat (dredging) in the Yankee Fork; habitat restoration will take many years.

Wenatchee and Methow

199604000	Mid-Columbia Reintroduction Feasibility Study	Yakama Confederated Tribes
200900100	Upper Columbia Spring Chinook and Steelhead Acclimation	Yakama Confederated Tribes

199604000 - Mid-Columbia Reintroduction Feasibility Study

Links to: project **and** reports

Proponent: Yakama Confederated Tribes

Province/subbasin: Columbia Cascade/Methow, Columbia Cascade/Wenatchee

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?

Indirect or Potential

- Fish Propagation: What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles and from harvest in fisheries targeting hatchery-origin adults?

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Recolonization: Can extirpated populations be recolonized by relying on out-of-basin brood stock?

Comment:

This hatchery and monitoring project primarily addresses an additional uncertainty (not in the 2006 Research Plan) about how best to restore an extirpated population by relying on out-of-basin brood-stock and attempting to promote local adaptation in the naturally spawning component of the reintroduced population. It also directly addresses the 2006 critical uncertainty about fish propagation related to interactions between hatchery-reared fish (coho) and other wild species (e.g., Chinook).

The project indirectly addresses two other 2006 uncertainties about fish propagation related to the cost to natural populations from interactions with hatchery-origin juveniles, and the magnitude of demographic benefits to the production of natural-origin juveniles.

It could potentially address other 2006 uncertainties related to hydrosystem impacts on survival (juvenile releases are PIT-tagged, and SARs are evaluated), and population structure and diversity (spatial and temporal distribution and other attributes of natural spawners are monitored).

Methods: Seem appropriate. Reviewed favorably by the ISRP (2006).

Program Relevance and Project Results: This project is intended to restore coho salmon to the Wenatchee and Methow river basins through development of locally adapted, naturally spawning populations. Its feasibility initially depended upon the adaptability of domesticated, lower Columbia coho stocks used in the re-introduction efforts and the potential for ecological risk to other species of concern, such as ESA listed spring Chinook, steelhead, and bull trout. Both of these key issues have been resolved favorably and the transition has been made from using exclusively lower Columbia River hatchery coho to the sole use of in-basin, locally adapted broodstock. Surveys are conducted to monitor the spawning abundance, spatial and temporal distribution, stray rates and age composition of naturally spawning adult coho in both rivers, to assess the success of the reintroduction program and to inform hatchery production decisions. Hatchery-reared juveniles are PIT-tagged to estimate SARs in both rivers. Natural spawning is not yet sustainable at current SARs (~0.3% in 2013).

Reporting: Annual reports are detailed, well written, and reasonably up-to-date (results reported through 2013), but they all focus on individual years. No retrospective synthesis of the project was provided, and little or no information that described how analyses or evaluations were used to influence management decisions was presented.

Broad Applicability: Results from this project apply primarily to coho salmon in Wenatchee and Methow rivers but lessons learned about strategies that promote local adaptation there would likely be useful elsewhere.

Time Required: This long-term project began releasing juvenile coho experimentally in 1998 but has now transitioned from using exclusively lower Columbia River hatchery coho to the sole use of in-basin, locally adapted broodstock. Natural spawning is not yet sustainable at current SARs (~0.3% in 2013), but SARs are expected to improve as the reintroduced populations become better adapted to their new environments.

200900100 – Upper Columbia Spring Chinook and Steelhead Acclimation

Links to: project **and** reports

Proponent: Yakama Confederated Tribes

Province/subbasin: Columbia Cascade/Methow, Columbia Cascade/Wenatchee

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

Indirect or Potential

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both

hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?

- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?

Comment:

This supplementation-related project directly addresses three 2006 critical uncertainties about fish propagation in that it evaluates the use of acclimation ponds to reduce straying (and thus the extent of interactions between production-hatchery fish and naturally produced wild fish) and to avoid exceeding the carrying capacity of certain spawning areas (which should also increase the magnitude of demographic benefits in natural production from supplementation).

The project could potentially address other uncertainties related to harvest, habitat, and hydrosystem impacts (because migratory survival metrics are measured through PIT tag detection).

Methods: Seem appropriate. Note that the ISRP (2009) concluded: "it is not clear how the additional ponds will add to the spawning distribution. Without knowing where the current hatchery steelhead spawn, it is not possible to know whether there are reaches that have suitable habitat but are underseeded. At this time the Proportionate Natural Influence (PNI) for each of these programs is very small, and there is a need to progress toward larger proportions of natural fish on the spawning grounds and in any artificial production. So it is not clear that there is a need or desire to substantially expand the natural spawning by hatchery-origin adults."

However, the project proponents have cited subsequent research that shows that the reproductive success of naturally spawning hatchery origin fish can be significantly reduced relative to natural origin fish because of where they spawn. Conversely, within the Wenatchee Basin, hatchery spring Chinook that spawn in areas of high quality habitat (Little Wenatchee and White Rivers) with low spawner densities are have reproductive success values that are comparable to natural origin spawners (Ford et al. 2013).

Program Relevance and Project Results: The Project uses natural ponds for short-term acclimation to improve the efficacy of existing supplementation programs for spring Chinook and steelhead in the Wenatchee and Methow basins. Acclimation can improve the efficacy of supplementation programs by returning hatchery fish to available habitat where they may successfully spawn rather than returning to the location of the hatchery where habitat quality may be affected by high densities of hatchery returns. This approach is also expected to disperse returning adults to correct locations and to produce higher smolt to adult survival rates than direct scatter plants or large single point releases.

Reporting: The reporting is up to date (the latest report covers the first 4 years of the project) and provides considerable, well-organized detail about the background for the project, activities to date and survival rates at different stages.

Broad Applicability: Results from this project apply primarily to Chinook and steelhead in the Methow and Wenatchee rivers, but they will likely be broadly applicable to the Columbia Basin.

Time Required: This project began in 2009. Much of the efforts under this project to date have been focused on identifying and permitting acclimation sites, developing acclimation plans, and addressing technical uncertainties about target densities for multi-species acclimation. Improvements in homing fidelity cannot be assessed until the adult return data from release groups are complete (2016-2018).

Okanogan

200302300 - Chief Joseph Hatchery Program

Links to: project **and** reports

Proponent: Colville Confederated Tribes

Province/subbasin: Columbia Cascade/Okanogan

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?

Indirect or Potential:

- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?

- Mainstem Hydrosystem Flow and Passage Operations: What are the optimal temperature and water quality regimes for fish survival in tributary and mainstem reaches affected by dams, and are there options for hydrosystem operations that would enable these optimal water quality characteristics to be achieved? What would be the effects of such changes in operations and environment on fish, shoreline and riparian habitat, and wildlife?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?

Comment:

This hatchery and monitoring project proposes to directly address several 2006 critical uncertainties about fish propagation. Genetic studies and parent-based tagging methods will be used to investigate interactions between hatchery origin and natural origin Chinook, their relative reproductive success, and the effectiveness of HSRG guidelines. Enumeration at both juvenile and adult stages in combination with a marking program will directly address the utilization and carrying capacity of freshwater habitat by natural-origin Chinook.

The project indirectly addresses two other 2006 uncertainties related to hydrosystem impacts on survival (juvenile releases are PIT-tagged, and SARs are evaluated in relation to temperature data) and population structure and diversity (spatial and temporal distribution and other attributes of natural spawners will be monitored).

Methods: Monitoring methods currently include marking (adipose clips, CWT and PIT tags), juvenile and adult sampling in the field (rotary screw trapping, beach seining, weir, carcass surveys), and genetic sampling. The approach seems appropriate to evaluate straying and the proportion of hatchery origin fish in the natural spawning population (pHOS), and trends in abundance, timing, survival and exploitation rates. In addition, genetic baselines are being developed to monitor trends in genetic diversity (allele frequencies), to determine relative reproductive success of hatchery origin returns (HO) and natural origin returns (NO), hatchery contribution to natural production, and effective population size, and to develop the capability for parent-based tagging and environmental DNA analysis to detect utilization of tributaries by Chinook.

Program Relevance and Project Results: The Chief Joseph Hatchery Program has been developed from Hatchery Science Review Group (HSRG) recommendations and multiple independent science reviews. The program is managed for variable smolt production and natural escapement because success will be based on meeting Hatchery Genetic Management Plan (HGMP) targets for abundance and composition of natural escapement and hatchery broodstock.

In 2014, the current plan is to run at full program levels of 2 million summer/fall Chinook and 900,000 spring Chinook. The path forward for 2014 includes continued monitoring of all program activities and fish population status and trends. Beginning in 2016, the project will monitor effectiveness and status and trend parameters such as relative reproductive success, program-specific genetic profiling, smolt-to-adult-returns (SARs), age-at-return, abundance, escapement, stray rates, stock composition, and distribution. Strategic planning workshops will be convened to determine how the current scope of work should change after 2018 when adult fish returns begin to overlap and juvenile release groups will be present throughout the region.

Reporting: The project's first annual report (2013) is detailed and well organized.

Broad Applicability: Results from this project apply primarily to Chinook salmon in the Upper Columbia, but lessons learned there about new hatchery management tactics would likely be useful elsewhere.

Time Required: This long-term project only just began (first annual report completed for 2013) and continued monitoring is proposed for foreseeable future (>5 years).

Habitat Action Effectiveness Research – ISEMP and CHaMP

200301700 - Integrated Status and Effectiveness Monitoring Program (ISEMP)

Links to: project **and** reports

201100600 - Columbia Habitat and Monitoring Program - Pilot (CHaMP-P)

Links to: project **and** reports

Proponent: National Oceanic and Atmospheric Administration

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Monitoring and Evaluation (adaptive management): Can a common probabilistic (statistical) site selection procedure for population and habitat status and trend monitoring be developed cooperatively?
- Monitoring and Evaluation (adaptive management): Can a scientifically credible trend monitoring procedure based on remote sensing, photography, and data layers in a GIS format be developed?
- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

- Monitoring and Evaluation (adaptive management): Make best professional judgment, based on available data, as to whether any new research in the spirit of the Intensive Watershed Monitoring approach should be instigated immediately. Most new intensive research should arise as a result of the interaction of existing inventory data with new data arising in population and habitat status and trend monitoring.

Indirect or Potential:

- Human Development: What changes in human population density, distribution, and economic activity are expected over the next 20 years? 50 years?
- Human Development: How might the projected changes under different development scenarios affect land use patterns, protection and restoration efforts, habitats, and fish and wildlife populations?
- Population Structure and Diversity: What approaches to population recovery and habitat restoration are most effective in regaining meta-population structure and diversity that will increase viability of fish and wildlife in the Columbia River Basin?

Comment:

These uncertainties apply to project numbers 2003-017-00 and 2011-006-00.

The ISAB and ISRP did not review BPA's Action Effectiveness Monitoring (AEM) program as part of this uncertainties evaluation, but the ISRP is scheduled to review the AEM program in 2016.

Reports reviewed:

I**SEMP. 2014. The Integrated Status and Effectiveness Monitoring Program: Annual Report for Fiscal Year 2013.** BPA Project No. 2003-017-00. Bonneville Power Administration. 46 p.

CHaMP. 2015. The Columbia Habitat Monitoring Program: 2013 Third Year Lessons Learned Project Synthesis Report. BPA Project No. 2011-006-00. Bonneville Power Administration. 67 pages.

ISEMP/CHaMP. 2015. Combined Annual Technical Report for the Integrated Status and Effectiveness Monitoring Program and Columbia Habitat Monitoring Program: 2014. BPA Projects 2003-017-00 and 2011-006-00. Bonneville Power Administration. 172 p.

Methods: ISEMP uses habitat data generated by CHaMP and biological data collected for this program to answer three key management questions (which could themselves be considered critical uncertainties) that are tied to the most recent Biological Opinion:

1. What habitat factors limit species recovery in tributaries?
2. What is the relationship between habitat factors and fish survival and productivity in tributaries, and what habitat restoration activities are most cost effective?
3. Is habitat restoration in tributaries meeting (or likely to meet) goals for restoring listed species?

ISEMP uses a set of modeling approaches to analyze these data to specifically address these questions, including habitat suitability indices, life cycle models, models that predict net rate of energy intake for foraging salmonids, and empirical fish-habitat relationships. The ultimate goal is to provide a set of tools that can be applied across the entire Columbia River Basin. This requires tests of different tools and the scaling up of localized and reach-level measurements and analyses. It is the creative use of novel modeling approaches that sets ISEMP apart from most other Columbia Basin tributary habitat restoration approaches. That they have listened carefully to the needs of managers is reflected in the following passage (p. 35 of 2013 Annual Report):

> *"…restoration planners do not want opportunistic approaches to habitat restoration, a mountain of raw data (measurements or metrics), or fancy models. What they do want is useful and applicable information summarized and mapped at a spatial resolution useful for planning… With this in mind we are developing products that will provide:*
>
> - *Guidance on (a) life-stage specific and (b) population-level limiting factors (see Chapter II)*
> - *Likely outcomes of alternative restoration scenarios (this chapter)"*

However, there were several drawbacks to both reports, which the ISAB/ISRP will address more completely in a longer memo.

- The details of methods, measurements, models, and statistical approaches was either quite general (ISEMP 2013 Annual Report) or the treatment uneven among methods (2014 Combined Annual Report), and in both cases the descriptions were often hampered and made unclear by jargon. In some cases key methods or analyses are described only in other documents, such as the measurement and analysis of gross primary production for use in predicting salmonid densities.

- Some approaches used to generate accurate predictions of fish responses to restoration actions may not be suitable, or have not been tested sufficiently for broad use. For example:
    - ISEMP and CHaMP use River Styles as a means for geomorphic characterization (Brierley and Fryirs 2005, Blackwell Publishing, Oxford 398pp). The original intent was that these "styles" would equate to different river physical settings, which would underpin ecological responses and provide a template for restoration. So far, it does not appear that any meaningful relationships between the various river "styles" and patterns of biodiversity or ecosystem processes have been demonstrated in the broader literature (see Thompson et al. 2003. Are River Styles ecologically meaningful? A test of the ecological significance of a geomorphic river characterization scheme. Aquatic Conservation DOI: 10.1002/aqc.585). Overall, the usefulness of this approach for evaluating restoration actions requires additional careful examination.

    - Further, it is not clear how the Geomorphic Unit Tool (GUT) relates to predicting ecological processes or structural characteristics. ISEMP and CHaMP are in the process of testing a Geomorphic Unit Tool that will automate a portion of their River Styles implementation effort in order to support implementation of the process-based hierarchical geomorphic unit classification system. This, too, should be carefully examined as being a valid method.

    - Although the hydraulic models appear to be working well, there is no quantitative (or predictive) linkage to the effectiveness of fish restoration actions. We note that plans appear to be underway to do so.

- CHaMP is designed for summer habitat survey protocols and would probably need a somewhat different set of protocols for winter habitat sampling. As to biological measurements across seasons, we note that winter growth and survival were measured for steelhead and Chinook as part of the three Intensively Monitored Watersheds. This is a particularly important aspect of the work.

Program Relevance and Project Results: The program is directly relevant to critical uncertainties for tributary habitat and monitoring and evaluation. For example, empirical fish-habitat relationships are being developed from mapped geomorphic and other data that allow spatially explicit estimates of survival and productivity (e.g., smolts/spawner) over subbasins, and eventually larger areas. The multiple modeling approaches are being combined to assess accuracy of these estimates.

Main products and findings include:

a. A standardized CHaMP protocol has been developed and refined for measuring and analyzing habitat for salmonids in tributaries that can be waded, and methods have been developed to analyze these data to produce metrics important to fish (e.g., using hydraulic models)
b. Three Intensively Monitored Watersheds were selected in which habitat and fish have been measured in detail, to produce life-stage specific estimates of abundance, growth, survival, and emigration for Chinook salmon and steelhead before, during, and after watershed and habitat restoration.
c. Methods and analyses have been developed to estimate status and trends of habitat using spatially balanced designs, and to interpolate and extrapolate results for unmeasured segments and watersheds based on modeling and empirical relationships.
d. Analytical tools have been developed to predict fish responses from habitat across various spatial scales, with hopes of predicting responses of fish to changes created by habitat restoration.

Broad Applicability: The models are being developed and tested in three main subbasins, and there is promise of applying them more widely. However, given the complexity of these kinds of relationships, with much unexplained variation that may depend on other unmeasured variables, it will remain to be seen whether the models can predict fish survival or productivity across large areas. There will likely always be limits to this predictability, but the ISEMP approach is the most comprehensive to date. It is commendable that they are exploring several different tools that may be used in a complementary fashion. We are pleased that ISEMP holds periodic workshops to discuss new findings and receive feedback from restoration practitioners and habitat managers.

Time Required: The process has been ongoing since 2003 and represents a huge challenge and requires exceptional effort. Continued monitoring is needed to ensure consistent collection of relevant data to test and verify the models. Peer-reviewed publication of the results are recommended to verify and support the credibility of the methods and analyses. Completing the modeling and development of useful tools will likely require another four years at least.

Quality of Annual Report: ISAB/ISRP first reviewed the 2013 Annual Report and wrote a synthesis, but as it was being completed the 2014 Combined Report was released so it was also reviewed. The 2013 reports are relatively brief summaries and lack some of the detail needed by reviewers to understand each of the four main modeling efforts. The 2014 Combined Report was more comprehensive, but treated the different methods and analyses unevenly. In addition, a substantial number of the relationships and figures presented were too small or fuzzy to be read and interpreted, and they lacked the definitions (e.g., of units and axes) needed to interpret them. All the reports are data rich and wide-ranging but could have been more carefully edited to improve readability.

Climate Change

200900800 - Climate Change Impacts

Links to: project **and** reports

Proponent: Columbia River Inter-Tribal Fish Commission (CRITFC)

2006 Research Plan uncertainties addressed:

Direct:

- Climate Change: Can integrated ecological monitoring be used to determine how climate change simultaneously affects fish and wildlife and the freshwater, estuarine, ocean, and terrestrial habitats and ecosystems that sustain them?
- Climate Change: Can indices of climate change be used to better understand and predict interannual and interdecadal changes in production, abundance, diversity, and distribution of Columbia Basin fish and wildlife?
- Climate Change: What long-term changes are predicted in the Columbia River Basin and the northeast Pacific Ocean, how will they affect the fish and wildlife in the region, and what actions can ameliorate increased water temperatures, decreased summer river flows, and other ecosystem changes?

Indirect or potential:

- Human Development: What changes in human population density, distribution, and economic activity are expected over the next 20 years? 50 years?

- Human Development: How might the projected changes under different development scenarios affect land use patterns, protection and restoration efforts, habitats, and fish and wildlife populations?

Comment:

Through this Accord Project, CRITFC is assisting member tribes (Nez Perce, Yakama, Warm Springs and Umatilla) to develop climate change adaptive management strategies and management actions to protect first foods (fish, plants, wildlife). At this time, the project is not working to analyze and understand the effects of climate change on first foods. That is, it does not currently address the critical uncertainties about the effects of climate change on biota.

In 2014, efforts continued towards the development of sophisticated Columbia River Basin river operations modeling tools with the CRITFC Information System (CIS) and the integration of the most recent climate science into these tools. Overall, the project has allowed CRITFC to develop expertise in climate change impacts and to develop their own accounting system of how this will affect river flows and ecosystem restoration.

The CRITFC Information System (CIS- formally CRITFC HYDSIM model) is based on BPA's HYDSIM model and is comprised of various data libraries where reservoir operational rule curves and mainstem flows can be modified from various assumptions including climate change futures. It is not clear from the reports what actual model development CRITFC conducted, the additional functionality that warranted developing CIS, and how (or if) they ran the models. It appears that added functionality will be the development of quantitative models that predict ecosystem, community, and species responses. However, the lack of clear descriptions of some components (e.g. "14 period," fish survival model, implementation of ecosystem function curves) made it unclear how and whether these components were implemented and/or can produce reliable results. Furthermore, a discussion of uncertainties of the model would be helpful.

In a recent presentation to the ISAB/ISRP, CRITFC staff explained that the CIS model uses the same information as the USACE, BPA, Council, and others. Through cooperation with NOAA, 70- to 80-year records have been incorporated. In order to accomplish modeling efficiency, the model uses a database platform which can run in a few minutes while BPA's spreadsheet method may take weeks to run—i.e., a normal sixty-step process is done at once instead of step-by-step. The CIS-results can be output to Excel for use by managers and decision-makers. Graphs are also produced automatically through the settings, and manual manipulation is not necessary. The project is also producing ecosystem rule curves.

At this time, it is unclear how results or models will address the uncertainties, especially how the physical model(s) will be connected to biological outcomes that would have broad applicability. It may address some of the listed uncertainties, but the results will not be conclusive.

This project may need more critical review by ISRP to understand its goals and direction and products.

Methods: In addition to model development described above, CRITFC staff organized climate-related workshops, attended climate meetings, helped organize conferences, and participated in several regional climate activities.

Program Relevance and Project Results: This is a research project with no hypotheses presented and no direct monitoring conducted.

Broad Applicability: If successful and not duplicative of other efforts, the climate modeling outputs may be useful for water and fish management in the Columbia River Basin and, thereby, have broad applications here and elsewhere. The project will have added value when/if physical models are connected to biological outcomes.

Time Required: It is likely that at least an additional 3-5 years will be needed before the modeling tools are operational and tested. Afterward, it will be necessary to support climate-related core staff for the foreseeable future.

Hyporheic Flow

200725200 - Hyporheic Flow Assessment in Columbia River Tributaries

Links to: project **and** reports

Proponent: Umatilla Confederated Tribes (CTUIR)

Province/subbasin: Columbia Plateau/Umatilla

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Climate Change: What long-term changes are predicted in the Columbia River Basin and the northeast Pacific Ocean, how will they affect the fish and wildlife in the region, and what actions can ameliorate increased water temperatures, decreased summer river flows, and other ecosystem changes?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- How can habitat restoration activities or hydrosystem operations modify groundwater-surface water interactions to improve survival, productivity, distribution, and abundance of anadromous and resident native fish populations?

Comment:

This project addresses the two uncertainties indirectly. The proponents are attempting to develop relationships between hyporheic flow and water temperature signatures to predict what natural or restored conditions of floodplains would best support native salmonids. The results could be used to infer the effects of climate change and, even more indirectly, whether habitat restoration in tributaries could improve survival or productivity for native salmonids.

Methods: The investigators developed a model to simulate water temperature in stream channels of mid-Columbia tributaries based on temperature, flow, and fluxes of energy between the atmosphere and stream, and the stream and its hyporheic zone. They test one aspect of the model using an artificial tank and then test the sensitivity of the model by varying the size of, and exchange rates with, the hyporheic zone in three types of channels. They use the model to predict hyporheic temperature signatures in different simulated field settings. They are apparently measuring these temperature signatures in at least one floodplain, but when, where, and how long this is being measured is unclear from the most recent report.

Program Relevance and Project Results: The stated objective is "to create a model that accurately predicts stream temperature fluctuations by accounting for hyporheic and atmospheric influences." The model was created, one aspect was tested using an artificial tank, and simulations were run. However, it is unclear whether the model itself will be tested against real data and whether and why models already available in HeatSource are not suitable instead of developing a new model. The reliability of the model was called into question by ISRP/ISAB reviewers, who also commented that validation of one part of the model against an artificial pond does not seem suitable for applying the model to stream reaches.

Broad Applicability: It is unclear whether the model could be broadly applicable without clearer explanation of the model and the real-world data against which it will be tested.

Time Required: It is unclear how much time will be required to complete the project, and how the data and results will be disseminated.

Quality of annual report: Overall, the annual report was lacking critical information on how the model was developed, and how the data were collected, checked for accuracy, and disseminated. Field validation of the model was unclear. The report did not provide the information needed to determine whether either critical uncertainty was addressed.

Water Transactions

200201301	Water Entity - CBWTP	National Fish and Wildlife Foundation
200810400	Land & Water Acquisition	Colville Confederated Tribes, National Fish and Wildlife Foundation
200820600	Instream Flow Restoration	Umatilla Confederated Tribes (CTUIR)
200860800	Idaho MOA/Fish Accord Water Transactions	Idaho Department of Water Resources (IDWR), Idaho Office of Species Conservation

Summary
Protecting and restoring instream flows are expected to yield important benefits in the recovery of fish and wildlife. Monitoring of water transactions has been useful for compliance evaluation but has provided little insight into the needs of or benefits to fish and other aquatic communities. Water transaction programs funded by BPA to address instream flows would be improved with ecological-response monitoring. Without that type of monitoring, it is unlikely that these programs will address uncertainties around limiting habitats and restoration effectiveness. Instead, new uncertainties arise around the effectiveness of water transactions.

200201301 - Water Entity - Water Transaction Program

Links to: project and reports

Proponent: National Fish and Wildlife Foundation

Subprojects:

200810400 - Land & Water Acquisition

Links to: project and reports

Proponent: Colville Confederated Tribes, National Fish and Wildlife Foundation

200820600 – Instream Flow Restoration

Links to: project and reports

Proponent: Confederated Tribes of Warm Springs

Province/subbasin: Columbia Plateau/Deschutes

200860800 - Idaho MOA/Fish Accord Water Transactions

Links to: project and reports

Proponent: Idaho Department of Water Resources (IDWR), Idaho Office of Species Conservation

Province/subbasin: Mountain Snake/Salmon

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- Can social engagement and economic incentives be used to increase water flow in salmon-bearing rivers?
- Is it feasible to purchase enough water, or change timing or location sufficiently, to improve ecological functions?
- Many water purchases are short term, and may only be for one year, or a short period. Are these short periods sufficient to create a meaningful impact?
- Measuring whether contracted water is actually delivered to the river is an important uncertainty. Trying to understand effectiveness is challenged by monitoring that is often based on cooperators and uneven efforts.

Comment:

The Columbia Basin Water Transactions Program (CBWTP) facilitates the purchase or lease of water rights for the Fish and Wildlife Program and includes efforts to conduct and track biological effects of water transactions. The Water Transaction Program is essentially an umbrella project and includes three other Fish and Wildlife Program projects. The ISAB and ISRP reviewed annual reports directed at Pisces requirements and also an annual report intended for public outreach.

Based on the issues discussed below, it is unlikely that results from the project are statistically reliable or can be used to help resolve any of the 2006 Research Plan uncertainties. Additional uncertainties are relevant to this study, as noted above. However, unless the study incorporates controls and begins to measure biological responses, it is unlikely that advances on these uncertainties will originate from the project. Because of these difficulties the effectiveness of water purchases are unknown.

The CBWTP public outreach report summarizes results for four projects. This is a report with nice images, infographics, and storytelling. It is a great report to share with stakeholders, but lacks some technical information. There is no information, for instance, on compliance monitoring or that can be used to evaluate impacts to ecosystems. In addition, the actual amount of flows attributed to new projects are a bit hard to determine as different achievements are reported in different ways in the document. It appears, however, that new projects are protecting 62 cfs of instream flows. The report refers readers to a website (www.cbwtp.org) for data and metrics about the projects, but technical information about the water transactions that were discussed in the reports was not found.

The progress report for the Idaho MOA project describes enhancing flows in the Lemhi and Pahsimeroi Rivers and reports securing 29 cfs of instream flows via 7 water transactions.

Methods: The methods for recruiting and implementing water transactions are not explained. Regarding M&E monitoring, not enough information about methods is provided (for example, how were monitoring sites selected? What techniques were employed?). Data that are provided mainly come from voluntary monitoring efforts. This has made it difficult to develop a well-organized and formal approach to evaluate implementation and effectiveness. Data and results include PHABSIM analysis, PIT tag adult counts, redd counts, snorkel counts of juveniles, macroinvertebrate sampling and summer temperature monitoring.

The authors note that it is difficult to acquire habitat data from their project partners in a timely manner, in part due to internal review and release of data to the public from the partners collecting the data. This makes it hard for CBWTP to report current data in their annual reports, so they comment that they will report data from the previous year in future reports so that they are more complete.

Program Relevance and Project Results: Status and trend M&E is reported that tracks outcomes for the Columbia Basin Water Transactions Program (CBWTP).

Broad Applicability: The study design is not adequate for transferring results elsewhere. This is largely a result of the fact that "Funding for RM&E activities is limited and therefore many of the CBWTP's efforts are voluntary and rely heavily on leveraging the efforts of partner organizations to collect and analyze data." Thus, data collection is a slightly ad hoc and has no basis for establishing causality/effectiveness. In addition, before results can be transferred to other parts of the Basin, data from project sites will need to be summarized and synthesized.

Time Required: This is an ongoing water transaction project**.**

Nutrients

200847100	Upper Columbia Nutrient Supplementation	Yakama Confederated Tribes
200890400	Salmon River Basin Nutrient Enhancement	Shoshone-Bannock Tribes

200847100 - Upper Columbia Nutrient Supplementation

Links to: project **and** reports

Proponent: Yakama Confederated Tribes

Province/subbasin: Columbia Cascade/Wenatchee

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Harvest: How can the multiple ecological benefits that salmon provide to the watersheds where they spawn (e.g., provision of a food resource for wildlife and a nutrient source for streams and riparian areas) be incorporated effectively into procedures for establishing escapement goals?

Comment:

It appears this project was completed. The project could not draw conclusions from the results because the experimental design was confounded, without appropriate controls. This project was used as a reference site in a 2012 paper: Kohler, A.E., T.N. Pearsons, J.S. Zendt, M.G. Mesa, C.L. Johnson, and P.J. Connolly. 2012. Nutrient Enrichment with Salmon Carcass Analogs in the Columbia River Basin, USA: A Stream Food Web Analysis, Transactions of the American Fisheries Society 141:3, 802-824s.

General Comment: UCNPRP collected baseline "pre-treatment" data covering aspects of epilithic periphyton community structure and production, benthic and terrestrial macroinvertebrate community structure and production, and fish production at Hancock Springs Creek, near Winthrop, WA. Ultimately, these data will be used to provide the foundation for energy flow web-based analyses describing the effects of nutrient additions in Hancock Springs Creek.

Methods: Standard methods were used for specific aspects of the study.

Program Relevance and Project Results: Most data are from 2014, although data for some ecosystem components were collected during previous years. During 2014 water chemistry parameters were moderately variable over space and time. In 2013, periphyton standing crop biomass and Chl-*a* concentration from rock scrapings also exhibited substantial spatial variability, along with some moderate seasonal trends. However, samples from Reach 1 (treatment) were more homogenous than those collected within Reach 2 (reference), probably due to riparian characteristics. Between 2012 and 2013, aquatic insect annual production and mean biomass density showed little variation within each reach. In 2014, fish populations in Reach 1 exhibited consistent trends of greater abundance and biomass densities, organismal growth rates, and annual production values, compared to fishes in Reach 2. Within Reach 1, Chinook salmon and bull trout exhibited seasonal patterns consistent with documented life history patterns and associated behaviors, while other fishes exhibited a relatively high degree of stability. Among fish species sampled, diet compositions were consistent across years for all species except bull trout, which appear to exhibit opportunism regarding prey items chosen. Overall, project level monitoring was conducted but only for short periods (1-2 years).

Broad Applicability: Due to the relatively unique nature of this spring-fed stream, it is not clear that the results can be broadly applied to other small streams in the region.

Time Required: It appears this project was completed.

200890400 - Salmon River Basin Nutrient Enhancement

Links to: [project]() **and** [reports]()

Proponent: Shoshone-Bannock Tribes

Province/subbasin: Upper Snake/Snake Upper

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Harvest: How can the multiple ecological benefits that salmon provide to the watersheds where they spawn (e.g., provision of a food resource for wildlife and a nutrient source for streams and riparian areas) be incorporated effectively into procedures for establishing escapement goals?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Will adding nutrients, carcass analogs or carcasses lead to increases in ecosystem-scale productivity and food web pathways that result in more fish of interest to the program, or will the nutrient additions lead to other food web pathways?

Comment:

Summary: The efficacy of nutrient enhancement is a key uncertainty; it is generally described in the 2006 Research Plan and included in the harvest uncertainty on how salmon carcasses and nutrients might influence spawning escapement goals. Key questions regarding nutrient enhancement include whether adding nutrients, carcass analogs, or carcasses will lead to increases in ecosystem-scale productivity and food web pathways that result in more fish of interest to the program, or will the nutrient additions lead to other food web pathways. Additionally, the reviewers wondered whether communication and collaboration among groups working on this issue in the same regions could be more effective, leading to greater advances in shorter periods.

Salmon analogs have been examined in a number of Columbia Basin streams via efforts funded by BPA (reviewed by Kohler et al. 2012, Transactions of the American Fisheries Society 141:802-824; Kohler et al. 2013, Canadian Journal of Fisheries and Aquatic Sciences 70:502-512). The study concluded that carcass analogs have the potential to increase the productivity of nutrient-limited freshwater ecosystems and may provide a nutrient mitigation tool in ecosystems where marine derived nutrients (MDNs) are severely limited or unavailable.

General Comment: The Salmon River Basin Nutrient Enhancement (SRBNE) project collects chemical, physical, and biological data to evaluate the efficacy of nutrient treatments designed to increase freshwater productivity and the growth and survival of stream-dwelling salmonids in the upper Salmon River Basin. This research project is addressing uncertainties about the effectiveness of nutrient enrichment treatments by experimentally enriching nutrient limited upper Salmon River subbasin streams with carbon, nitrogen, and phosphorus from salmon carcass analogs (SCA). Specific project objectives include the quantification and assessment of streamwater nutrient concentrations; nutrient limitation; course particulate organic matter retention; periphyton standing stock; macroinvertebrate (benthic and drift) density, biomass, and community composition; the bioenergetics of resident and anadromous fishes; leaf litter decay rates, river metabolism measures, and aquatic food web connections in treatment streams receiving nutrient additions and control streams that do not receive nutrient additions.

The most recent annual report is dated April 2014; many important analyses are stated as being available in summer 2014. The program evaluation is tentative without those data and analyses.

Methods: A variety of standard methods are used to measure ecosystem characteristics and nutrient fluxes (e.g., stable isotopes, Chl a). Hypotheses and objectives are clearly stated for each task. Analyses and reporting seem appropriate but are incomplete (behind schedule). The ISRP (2010) had requested responses to a number of questions about the experimental design and how nutrient limitations and responses would actually be measured; it's not clear whether those questions were addressed.

Program Relevance and Project Results: The relevance of the program is related to the decline in marine-derived nutrients (MDN) from spawning salmon in the upper Salmon River, and the ecosystem-scale effects of that MDN decline on the overall structure and productivity of the streams. Nutrients are added experimentally as carcass analogs (treatments and reference sites) and the results monitored. Trends and results to date (as of April 2014) are generally equivocal in terms of demonstrating effects of salmonid condition and productivity. While results to date demonstrate that SCA additions can generate short-term stream food web responses in study streams across a large spatial scale, it is not clear that the benefits of the added nutrients can stimulate the ecological system over the long term. Bioenergetics sampling demonstrated that SCA increased invertebrate drift densities but had little effect on estimates of suitable habitat for all post-treatment periods and for all size classes of salmonids.

Broad Applicability: If successful in demonstrating improvements to sustained salmon abundance and productivity, this project could have broad applicability to areas where MDNs have significantly declined. Although the method has broad applicability as a nutrient mitigation tool in ecosystems where MDNs are severely limited or unavailable, some key uncertainties remain (e.g., reason for inconsistent responses to SCA versus spawning salmon). Additional large-scale studies may be needed to inform management decisions. A very positive aspect is that at least three refereed papers have been published from the results of earlier studies in this project, lending experience and credibility to the work described here. However, there have apparently been no formal statistical analyses of the results from the 2010-2013 studies, and some samples remain to be processed and analyzed. These analyses will be needed before results can be interpreted and conclusions drawn. Nevertheless, even larger scale and longer term studies will likely be needed to develop robust conclusions on which management can be based, because adding nutrients has effects at watershed scales (and on fish that range widely), not the site scales at which studies have been conducted so far.

Time Required: An additional year or three at the most for an initial evaluation. Project data and results need to be independently evaluated before a decision can be reached on the future of the restoration actions. If the initial evaluation is favorable, then several more years will be needed to fully evaluate the population level responses of the fish, and the longer-term datasets will be needed to make ecologically meaningful inferences.

Habitat Project Effectiveness and Salmonid Habitat M&E by Geographic Area

Estuary

200300700	Lower Columbia River Estuary Ecosystem Monitoring	Lower Columbia Estuary Partnership
200301100	Columbia River Estuary Habitat Restoration	Lower Columbia Estuary Partnership
201000400	CREST Estuary Habitat Restoration	Columbia River Estuary Study Taskforce (CREST)
201007000	WA Estuary MOA Project Scoping & Implementation	Washington Department of Fish and Wildlife (WDFW)
201201500	Cowlitz Indian Tribe Estuary Restoration Program	Cowlitz Indian Tribe

Summary

Based on information in the annual reports, none of the five estuary projects reviewed are designed to directly test critical-uncertainty hypotheses. However, action-effectiveness and project-level monitoring and data collected by these projects have the potential to contribute substantially to Fish and Wildlife Program uncertainties research. In cases where uncertainties research was being conducted by sub-contractors or other agencies, the results generally were not well-documented in annual reports.

200300700 - Lower Columbia River Estuary Ecosystem Monitoring

Links to: project **and** reports

Proponent: Lower Columbia Estuary Partnership

Province/subbasin: Columbia River Estuary/Columbia Estuary, Lower Columbia/Columbia Lower

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Estuary: What is the significance to fish survival, production, and life-history diversities of habitat degradation or restoration in the estuary as compared with impacts to other habitats in the basin? How does this partitioning of effects vary among species and life-history types?
- Estuary: What are the highest priority estuarine habitat types and ecological functions for protection and restoration (e.g., what are most important habitats in the estuary for restoring and maintaining life-history diversities of fish, and how effective were past projects in restoring nursery/feeding areas)?

- Estuary: What specific factors affect survival and migration of species and life-history types of fish through the estuary, and how is the timing of ocean entry related to subsequent survival?
- Climate Change: Can integrated ecological monitoring be used to determine how climate change simultaneously affects fish and wildlife and the freshwater, estuarine, ocean, and terrestrial habitats and ecosystems that sustain them?
- Contaminants: How do toxic substances, alone and in combination, affect fish and wildlife distribution and abundance, survival, and productivity?
- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: What are the impacts of hydrosystem operations on mainstem habitats, including the freshwater tidal realm from Bonneville Dam to the salt wedge? How might hydrosystem operations be altered to recover mainstem habitats?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Human Development: How might the projected changes under different development scenarios affect land use patterns, protection and restoration efforts, habitats, and fish and wildlife populations?
- Mainstem Hydrosystem Flow and Passage Operations: What are the optimal temperature and water quality regimes for fish survival in tributary and mainstem reaches affected by dams, and are there options for hydrosystem operations that would enable these optimal water quality characteristics to be achieved? What would be the effects of such changes in operations and environment on fish, shoreline and riparian habitat, and wildlife?
- Mainstem Hydrosystem Flow and Passage Operations: What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species and stocks? What are the ecological effects of hydrosystem operations on downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?
- Monitoring and Evaluation (adaptive management): Can a common probabilistic (statistical) site selection procedure for population and habitat status and trend monitoring be developed cooperatively?

- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?
- Non-native and invasive species: What is the current distribution and abundance of invasive and deliberately introduced nonnative species (e.g., the baseline condition), and how is this distribution related to existing habitat conditions (e.g., flow and temperature regimes, human development, restoration actions)?

Comment:

This project is not designed to directly test hypotheses related to 2006 Research Plan uncertainties. However, data collected by the project can contribute substantially to addressing these uncertainties. The foci of action effectiveness monitoring (AEM) are to determine the effectiveness of habitat restoration actions on salmon recovery at the site and landscape scale, identify how restoration techniques address limiting factors for juvenile salmonids, and improve restoration techniques to maximize the effect of restoration actions.

Methods: This project monitors status and trends in the overall condition of different types of habitats within the estuary and lower river tidal habitats, stratified by hydrogeomorphic reach. It provides reference sites for use as end points in the region's habitat restoration actions and places findings from management actions into context with the larger ecosystem. For project-level monitoring, there are three levels of differing AEM intensity that are implemented at selected restoration sites. It is not entirely clear from information in annual reports how the sites are selected and AEM intensity levels assigned each year. Standardized monitoring protocols are employed, and the project coordinates stakeholders in the collection and sharing of AEM data. It was not discussed, or, apparent how similar the protocols are to those used for the AEM program in upper river areas. The project uses sound data analysis methods, although some of the data time series are still too short to yield statistically reliable results. Data on spatial and temporal patterns in vegetation and hydrology have been collected and analyzed since 2005, fish/fish prey since 2007/2008, and abiotic and food web conditions since 2011. Metrics collected include (1) salmonid occurrence, composition, growth, diet, condition and residency; (2) habitat structure, including physical, biological and chemical properties of habitats; (3) food web characteristics including composition, rates, and contribution to salmon diets of primary and secondary production within floodplain habitats and within the mainstem lower river; and (4) biogeochemistry of floodplain habitats and the lower estuary section.

Program Relevance and Project Results:

Status and trend M&E: This is a highly relevant, integrated status and trends monitoring program that is important for addressing key uncertainties for the lower Columbia River estuary. The 2015 report (https://pisces.bpa.gov/release/documents/DocumentViewer.aspx?doc=P143188) provides a synthesis of the Ecosystem Monitoring Program (EMP), trends (2005–2013) and food web dynamics (2011-2013). The report focuses analyses on two main components of the EMP: *variability* in the status and trends data for the habitat structure, habitat hydrology, fish and fish prey components collected between 2005 and 2013 and a *synthesis of food web dynamics* in the Lower Columbia River Estuary collected between 2011 and 2013. For fish, the analyses show a high degree of variability in many of the metrics, however, it is noted "… with the level of sampling conducted to date, we are able to detect seasonal and spatial trends in many of the variables we measured." A number of findings relevant to 2006 FWP uncertainties were reported. For example:

- Nutrient ratios indicate that phosphorus may be a limiting factor for phytoplankton growth in the mainstem. In addition, reoccurring annual patterns of increased nitrate levels and decreased dissolved oxygen in early September coincides with the cessation of managed spill from Bonneville Dam.
- Current sediment loads appear to remain adequate for increasing wetland area in the lower river over time. The implication of these observed sediment accretion rates for restoration is two-fold. First, sites that have subsided prior to restoration have the potential to recover elevation over time. Second, these rates should be factored into restoration designs to ensure the site will meet long-term goals. Specifically, considering the rate of elevation change could help determine the potential evolution of the plant community over time including the potential for reed canary grass invasion.
- Findings suggest that if high organic matter production (in support of the salmonid food web) is a habitat restoration goal, then high marshes should be one of the programmatic targets.

Exploratory multivariate analyses of food web dynamics were completed. It is reported "With only three years of food web data available at this time, our ability to detect patterns and trends from the multivariate analysis remains limited." The status of salmon habitat use during fall and winter is an area of uncertainty. Progress has been made in understanding the structure and function of the salmonid food web in emergent marsh habitats, but many knowledge gaps remain. A key component is the role of chemical contamination in the function of the salmonid food web. The project provides information for the Council's High Level Indicators for the estuary subbasin.

Action Effectiveness Monitoring: The program is very relevant for tracking the effectiveness of restoration treatments and for providing insights and lessons learned to improve individual treatments and the effectiveness of the whole program. Some findings were provided. Preliminary results, for sites with available water temperature data, indicate that after restoration water temperatures generally improve. Also, evaluation of passage and stream/riparian area treatments at Horsetail/Oneonta Creeks found juvenile and adult salmonids will pass through the "restored" Horsetail Creek culvert (under Interstate 84). In the spring, juvenile steelhead passed through the culvert, and most adult salmonids successfully transited through the culvert during periods of lower flows. In late summer and fall, the reconstructed western barrel (containing the fish ladder structure) was the only barrel with reasonable water depths (greater than six inches) and pools (created by a ladder structure). Also, a number of lessons learned were reported.

These include:

- Although a limited number of sites have pre- and post-restoration monitoring, initial analysis shows the need for not only reference sites but additional ecosystem monitoring sites to accurately characterize changes at the site scale and at larger spatial scales.

- With a lack of fish monitoring at AEM sites, comparing habitat metrics between restoration and reference sites is currently the only method to link restoration actions to realized fish use.

- Post restoration sites will need to achieve a new stable ecological state before restoration impacts related to vegetation composition and available salmonid prey can be determined.

- Based on early analysis covered in this report, the monitoring interval for standard (Level 3) metrics should be increased. Scheduling additional monitoring years could reduce uncertainty in the actual impact of restoration conditions versus confounding ambient environmental factors.

Broad Applicability: This project has broad applicability to estuary and tidal estuary habitats at multiple spatial scales. Sampling is done within five hydrogeomorphic reaches in the lower Columbia River. The intent is "to extrapolate to other sites in the river and eventually to the landscape scale." Within the five units, there is intent to be able to predict system responses to different conditions and ultimately adjust sampling methodology to improve the efficiency of the monitoring program in the future

Time Required: This project is designed to be a long term monitoring program. It is stated that the Comprehensive Conservation Management Plan (CCMP) specifically calls for sustained long-term monitoring to understand conditions throughout the river and to evaluate the trends and impacts of management actions over time. Many more years of investigation will be needed to gain an understanding of annual patterns and variation in food web structure.

200301100 - Columbia River Estuary Habitat Restoration

Links to: project **and** reports

Proponent: Lower Columbia Estuary Partnership

Province/subbasin: Columbia River Estuary/Columbia Estuary, Lower Columbia/Columbia Lower

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Estuary: What are the highest priority estuarine habitat types and ecological functions for protection and restoration (e.g., what are most important habitats in the estuary for restoring and maintaining life-history diversities of fish, and how effective were past projects in restoring nursery/feeding areas)?

- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Human Development: How might the projected changes under different development scenarios affect land use patterns, protection and restoration efforts, habitats, and fish and wildlife populations?

Comment:

This project does not directly test hypotheses related to 2006 Research Plan uncertainties. However, monitoring data collected by the project have the potential to contribute to uncertainties research.

Methods: The Lower Columbia Estuary Partnership identifies, develops, and implements estuarine habitat restoration projects. The project maintains a GIS database of restoration projects that includes maps of the site and data on the restoration entity, actions performed at the site, site descriptions, limiting factors and threats addressed; acres and stream miles protected or restored; costs, and known species using the site.

Program Relevance and Project Results: Ecosystem monitoring, action effectiveness monitoring, and implementation monitoring are all done by another BPA-funded project (#2003-007-00). Uncertainties research to address specific questions is done via the US Army Corps of Engineers. Project level monitoring through the project's GIS database contributes to HLIs related to improvements in estuarine habitat (e.g., acres and stream miles protected or restored).

Broad Applicability: The results have widespread applicability throughout the region and are applicable at multiple scales such as habitat type and species using the sites.

Time Required: This is an ongoing habitat restoration program. The most recent annual report is for the 2012-2013 budget period.

201000400 - CREST Estuary Habitat Restoration

Links to: project **and** reports

Proponent: Columbia River Estuary Study Taskforce (CREST)

Province/subbasin: Columbia River Estuary/Columbia Estuary

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Estuary: What are the highest priority estuarine habitat types and ecological functions for protection and restoration (e.g., what are most important habitats in the estuary for restoring and maintaining life-history diversities of fish, and how effective were past projects in restoring nursery/feeding areas)?

- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Human Development: How might the projected changes under different development scenarios affect land use patterns, protection and restoration efforts, habitats, and fish and wildlife populations?

Comment:

This project does not directly test hypotheses related to 2006 Research Plan uncertainties. However, monitoring data collected by the project has the potential to contribute to uncertainties research.

Methods: The Columbia River Estuary Study Taskforce (CREST) implements pre- and post-restoration project monitoring to better understand the impacts of habitat restoration effects on tidal habitats within the Lower Columbia River Estuary (LRCE). Monitoring is designed to quantitatively measure the impacts of specific restoration activities on certain habitat types. Metrics include water level/water quality, vegetation, photo points, and sediment accretion stakes. All methods are consistent with those described in "Monitoring Protocols for Salmon Habitat Restoration Projects in Lower Columbia River and Estuary " (Roegner et al., 2009, NOAA Technical Memorandum NMFS-nwfsc-97, 83pp.) and the "US Geological Survey, Western Ecological Research Center Invertebrate Lab Manual" (USGS 2010). Data collected at all of CREST's BPA sponsored projects are quality checked, processed, and provided to the Lower Columbia Estuary Partnership for inclusion in an estuary wide data set.

Program Relevance and Project Results: CREST completed seven BPA sponsored juvenile salmon habitat restoration projects in 2012 and 2013 and conducted effectiveness monitoring at these project sites: https://pisces.bpa.gov/release/documents/DocumentViewer.aspx?doc=P143111. They compared daily average temperatures (May-Sept) across sites and terrestrial macroinvertebrate prey at two restoration sites and their reference sites. Monitoring strategies varied between sites, with metrics depending on site conditions, funding, and directives from funding agencies. Monitoring metrics were decreased in 2013, limiting the degree to which treatment effects can be evaluated.

Broad Applicability: The results are broadly applicable to uncertainties related to the effectiveness of estuarine habitat restoration, but the only reported information on salmonid use of the restored habitats is indirect and qualitative.

Time Required: This is an ongoing habitat restoration project. Reporting of monitoring results reporting seems to take about 2-3 years given that the 2015 report covers 2012-2013.

201007000 - WA Estuary MOA Project Scoping & Implementation

Links to: project **and** reports

Proponent: Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Columbia River Estuary/Columbia Estuary

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Estuary: What are the highest priority estuarine habitat types and ecological functions for protection and restoration (e.g., what are most important habitats in the estuary for restoring and maintaining life-history diversities of fish, and how effective were past projects in restoring nursery/feeding areas)?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Human Development: How might the projected changes under different development scenarios affect land use patterns, protection and restoration efforts, habitats, and fish and wildlife populations?

Comment:

This project does not directly test hypotheses related to 2006 Research Plan uncertainties. However, monitoring data collected by the project has the potential to contribute to uncertainties research.

Methods: This administrative project does initial planning and restoration project scoping (maintain a project concept list), identifies and contacts willing landowners, scopes and develops proposed projects, uses Expert Regional Technical Group (ERTG) criteria to evaluate projects, coordinates with Action Agencies and regional stakeholders, develops proposals into Pisces statements of work, and initiates and responds to science reviews and otherwise plans for future project implementation. The most recent report submitted to BPA describes the Chinook Estuary Planning and Design project (https://pisces.bpa.gov/release/documents/DocumentViewer.aspx?doc=P139543).

Program Relevance and Project Results: Project-level action effectiveness monitoring of the Chinook Estuary project (more flexible tide gate openings) is conducted through a subcontract (PNNL), but findings were not presented in the most recent annual report. This monitoring will likely contribute information to the Council's estuary HLIs.

Broad Applicability: Results of the action effectiveness monitoring should be applicable across similar projects in the Columbia River estuary.

Time Required: This is an ongoing habitat restoration project that has reported results in a reasonable amount of time.

201201500 - Cowlitz Indian Tribe Estuary Restoration Program

Links to: project **and** reports

Proponent: Cowlitz Indian Tribe

Province/subbasin: Lower Columbia/Cowlitz

2006 Research Plan uncertainties addressed: None

Comment:

Methods: This is an administrative project focused on completing US Army Corps of Engineers Section 408 compliance needs for the Wallooskee-Youngs River Confluence Project.

Program Relevance and Project Results: At the present stage of this project, it does not seem relevant to research, status and trend M&E, or project level monitoring.

Broad Applicability: At present, results are only applicable at the project level.

Time Required: The project reported results in a reasonable amount of time.

Wind

199801900 - Wind River Watershed

Links to: project **and** reports

Proponent: Underwood Conservation District (UCD), US Forest Service (USFS), US Geological Survey (USGS), Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Columbia Gorge/Wind

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

Indirect or Potential:

- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?
- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

Comment:

Six critical uncertainties are linked to RME activities for this project. The three uncertainties related to habitat are addressed most directly through current RME activities.

Additional notes on the project are:

1. The status and trend portion of the project is developing useful data on native steelhead. This includes life history patterns, distribution of spawning and smolt production and survival among three

tributaries and the lower mainstem of Wind River. The project is poised to begin developing a life cycle model.

2. The effectiveness monitoring portion of the Project is using a well-designed, long term (10 yrs. +) study to evaluate the effects of Hemlock Dam removal. As noted in the report, "...adult and juvenile steelhead monitoring in this watershed has occurred at multiple control and impact sites for up to 20 years, which allows the testing of over a dozen unique dam removal hypotheses through Before-After-Control-Impact (BACI) type designs."

3. Wind River restoration activities are a good example of integrated, landscape scale work. There appears to be opportunities to synthesize data across projects and geographic areas to address the watershed-scale effectiveness of multiple protection and restoration treatments, designs, and combinations.

Methods: The project clearly documented the methods that were used for various activities and also highlighted possible shortcomings in the use of various methods. Statistical tests, used in data analyses are provided and rationale for their use often discussed. In a couple of instances, alternate methods were applied and results compared and discussed. The accuracy and precision of data and results are consistently discussed and often options or new methods for improvement are noted.

Program Relevance and Project Results: Monitoring activities are tied to project objectives, and this is beginning to provide a more complete understanding of steelhead abundance and productivity in the Wind River subbasin and its major tributary watersheds. Although the data are not currently being used in a life cycle model, the project proponents recommend that one be developed in the future as the data sets become more robust.

Results to date include (1) findings on relative levels of annual steelhead smolt production for the entire subbasin and relative contributions from various areas of the Wind River (three tributary watersheds and the lower mainstem); (2) annual estimates of adult escapement into the Wind River; (3) annual smolt to adult return rate (SAR) to Bonneville Dam showing that for outmigration years 2003 to 2011 and return years 2004 to 2014, SARs ranged from a low of 1.8% (outmigration years 2005 and 2011) to a high of 7.6% in 2009; and (4) preliminary analyses in 2014 that estimate freshwater habitat productivity and capacity for Wind River steelhead, noting that analysis of adult-to-adult productivity will occur in future years.

Preliminary action effectiveness monitoring results were also discussed for steelhead response to the removal of Hemlock Dam (2009) on Trout Creek, a major tributary system. Although final analysis and reporting of dam removal impacts has not been completed, and will require additional years of data collection, the report notes that preliminary qualitative results suggest that abundance of steelhead smolts and adults may be increasing in Trout Creek relative to other portions of the Wind subbasin.

Broad Applicability: Results have applicability for improved understanding of life history and abundance aspects of mid-Columbia summer steelhead. They provide additional insights into variability that occurs over time and space (geographically). Action effectiveness monitoring for the removal of Hemlock Dam to determine the biological response, over time, will provide useful information for other areas where major migration barriers have been removed/improved. It is noted in the report, "…adult and juvenile steelhead monitoring in this watershed has occurred at multiple control and impact sites for up to 20 years, which allows the testing of over a dozen unique dam removal hypotheses through Before-After-Control-Impact (BACI) type designs."

Time Required: This is an ongoing habitat restoration project. Useful results have been provided. It is likely that data will need to be gathered for more than 3-5 years to better understand survival and population trends given the relatively high natural variability encountered.

201003500 - Abundance, Productivity and Life History of Fifteenmile Creek Winter Steelhead

Links to: project **and** reports

Proponent: Oregon Department of Fish and Wildlife

Province/subbasin: Columbia Gorge/Fifteenmile

2006 Research Plan uncertainties addressed:

Indirect or Potential

- Climate Change: Can indices of climate change be used to better understand and predict interannual and interdecadal changes in production, abundance, diversity, and distribution of Columbia Basin fish and wildlife?
- Fish Propagation: What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles and from harvest in fisheries targeting hatchery-origin adults?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Mainstem Hydrosystem Flow and Passage Operations: What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species and stocks? What are the ecological effects of hydrosystem operations on downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?
- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

- Population Structure and Diversity: What approaches to population recovery and habitat restoration are most effective in regaining meta-population structure and diversity that will increase viability of fish and wildlife in the Columbia River Basin?

Comment:

The uncertainties that are most directly addressed by this project include the three Habitat Uncertainties: First, “Are the current procedures being used to identify......”; second, “To what extent do tributary habitat restoration actions affect survival, productivity......”; and third, “What pattern and amount of habitat protection and restoration is needed to ensure long-term viability.....” Also, there is likely direct benefit for ultimate resolution of a Population Structure and Diversity Uncertainty, “What approaches to population recovery and habitat restoration are most effective in regaining meta-population structure and diversity.....” In all cases, information is specific to a small subbasin in the Mid-Columbia.

This project is generating highly useful, long-term data on steelhead for this key, mid-Columbia, focal population. It is designed to establish a comprehensive monitoring and evaluation program for abundance, productivity, and life history of steelhead in the Fifteenmile Creek population and to improve the quality of the viability status assessments and serve as a basis for evaluating long term changes in productivity that may result from tributary habitat improvement of an ongoing project that is funded through Bonneville Power Administration (20 years+).

Methods: Standard methods have been used to gather and analyze data. There is a section to discuss each data gathering protocol with links to sites providing more detailed information. A relatively complete discussion on data qualifications and limitations is provided. A number of metrics including adult escapement and smolt abundance estimation are specifically addressed. Accuracy and precision appears to be adequate and appears to have improved over time. An example is the improvement of techniques for adult escapement where a combination resistance panel/video weir, to capture and enumerate returning adult steelhead, replaced stratified random spawning surveys, which were used prior to 2011.

Program Relevance and Project Results: The project is providing useful information for the management of this steelhead population. Some of the findings mentioned in the 2014 report include:

- Indications, based on smolt/adult results, that current rearing habitat is at capacity and that additional habitat restoration activities are required to increase the productivity and abundance of the Fifteenmile Creek population. This is based on data showing similar estimates of smolt production for the 2010 to 2013 outmigration years, despite varying adult escapement, that suggest production may have been near carrying capacity.

- Significant differences ($p < 0.05$) between SAR rates to Bonneville Dam and SAR rates to Fifteenmile Creek for the 2008, 2009, and 2010 are reported. This suggests a high mortality rate during Columbia River residence as pre-spawn adults and that recent PIT tag data from the Dalles Dam fish ladders indicates that the majority of Fifteenmile Creek steelhead ascend the ladders and pass above the dam in the summer and fall before returning to Fifteenmile Creek in the spring to spawn. It is concluded that this is one potential source of pre-spawn mortality that may be mitigated with flow augmentation at The Dalles Dam during critical migration months (December to March), particularly at the ice/trash sluiceway.

- Initial calculations of the recruits-per-spawner metric for the 2008 brood year (3.22 recruits-per-spawner) show a level that is well above the threshold productivity level identified in recovery planning. This is only a single data point and ongoing monitoring efforts will inform adaptive management strategies to insure that Fifteenmile Creek Steelhead remain a viable Mid-Columbia Distinct Population Segment (DPS) population.

Density Dependence***:*** This study is providing data to evaluate carrying capacity and density dependence of steelhead production in the Fifteenmile Subbasin. As noted in the 2014 report, "Results showing similar estimates of smolt production for the 2010 to 2013 outmigration years, despite varying adult escapement, suggest production may have been near carrying capacity…" and "Based on our smolt/adult results, we suggest additional habitat restoration activities are required to increase the productivity and abundance of the Fifteenmile Creek population."

Broad Applicability: The information is specific to the Fifteen Mile Creek winter steelhead populations. General findings from this project may provide insights into life history, abundance, and productivity of steelhead populations in other subbasins and their responses to habitat watershed scale restoration activities.

Time Required: This is a long term, status and trend project to track steelhead life history, abundance, and productivity and to report results of watershed-scale restoration. It will span multiple steelhead generations. As noted in the report, "With the development of newly implemented technologies, the Fifteenmile Creek watershed has developed into an ideally-sized watershed to monitor VSP parameters for a steelhead population recovery plan."

Klickitat

199705600 - Klickitat Watershed Enhancement

Links to: project **and** reports

Proponent: Yakama Confederated Tribes

Province/subbasin: Columbia Gorge/Klickitat

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

Indirect or Potential:

- Climate Change: Can integrated ecological monitoring be used to determine how climate change simultaneously affects fish and wildlife and the freshwater, estuarine, ocean, and terrestrial habitats and ecosystems that sustain them?
- Climate Change: What long-term changes are predicted in the Columbia River Basin and the northeast Pacific Ocean, how will they affect the fish and wildlife in the region, and what actions can ameliorate increased water temperatures, decreased summer river flows, and other ecosystem changes?

Comment:

Overall, project contributions to resolving uncertainties will be limited by the lack of a comprehensive organization to conduct monitoring and assessment activities and the apparent lack of integration of actual monitoring activities. Additionally, the lack of quantitative objectives for restoration activities limit interpretation of data relative to expected restoration outcomes. Also, there is no apparent linkage between project RME activities and basinwide programs like AEM, CHaMP, and ISEMP.

Additional summary comments include:

- This is a wide-ranging monitoring program for the Klickitat subbasin, but it was unclear how it will guide effective, adaptive management decisions for restoration. It appears that the monitoring has simply evolved over time, rather than being set up to test specific hypotheses.

- A general uncertainty for restoration, in this subbasin, is what extent and magnitude of restoration-induced, habitat changes will be needed to actually increase fish production to a level that can be detected.

Background: RME for this project is wide ranging and includes at least seven different, major activities. As noted in the 2012-2013 Annual Report, RME goals are to "…. Monitor watershed conditions to assess trends and effectiveness of restoration activities." It is noted that monitoring is a critical component for evaluating project success and guiding adaptive practices. Site-specific and basinwide spatial scales are addressed. Four of these activities are assessments that basically focus on watershed and streamflow characteristics in the subbasin. A Food Web Study (Teepee and White Creeks) and use of a "new" Habitat Assessment protocol (RAHAP) are described, but there is no discussion regarding links to AEM, CHaMP, or ISEMP programs.

Methods: Basic information on protocols is provided. Generally, standard methods appear to be used. There is limited presentation of analyses or discussion regarding the accuracy and precision of the data. There are some excellent examples of before/after photo points for evaluating results of various restoration projects. An impressive aspect of this is that "… photo-monitoring images are saved digitally, filed electronically in subdirectories by their respective project name and stored on the KWEP server." This will likely facilitate effective use and evaluation of photo-point images over time.

Program Relevance and Project Results: RME for this project is a mix of status/trend and project planning/assessment monitoring. Work ranges from basic streamflow (16 sites) and sediment monitoring to a new protocol (RAHAP) for habitat assessment and fish population. Additionally, there is a food web study on two of the watershed's tributaries. The purpose of the Habitat Assessment work is to "provide a single approach for effectiveness monitoring, status and trend monitoring, and to inform need, location, type, and project development." It involves development of a new protocol, "the Rapid Aquatic Habitat Assessment Protocol (RAHAP) (Romero and Lindley 2012). The RAHAP approach is: 1) spatially continuous, 2) relatively fast (per unit of collection), and 3) collects paired physical and fisheries data." There is no discussion of how this might link to CHaMP or ISEMP programs and their implementation.

The food web study is to "examine how instream restoration efforts along a 0.7-mile section of Tepee Creek affect aquatic and terrestrially derived invertebrate prey sources and diet of residualized *Oncorhynchus mykiss* and juvenile steelhead." There is no discussion regarding any results of this study, time frame for anticipated completion, or how results will be used to inform future restoration work in the subbasin.

It is apparent that assessment data are being used to guide location and design of restoration projects and that basic lessons learned are being gleaned from program activities. There is limited analysis of "true" monitoring work and few findings or conclusions are presented. There is limited linkage of monitoring with any quantitative, physical or biological, and program/project objectives.

Broad Applicability: Results are primarily useful at the site, watershed and subbasin scales for the Klickitat. Some basic approaches and treatment designs/results could have value in other geographic areas.

Time Required: Assessment results are being used to guide the location and design of protection/restoration projects. Results for monitoring activities are somewhat limited and there is little discussion regarding planned milestones for developing and applying results.

Rock Creek

200715600 - Rock Creek Fish and Habitat Assessment

Links to: project **and** reports

Proponent: Yakama Confederated Tribes

Province/subbasin: Columbia Plateau/Columbia Lower Middle

2006 Research Plan uncertainties addressed:

Direct:

- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?

Indirect or Potential:

- Climate Change: Can integrated ecological monitoring be used to determine how climate change simultaneously affects fish and wildlife and the freshwater, estuarine, ocean, and terrestrial habitats and ecosystems that sustain them?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Non-native and invasive species: What is the current distribution and abundance of invasive and deliberately introduced nonnative species (e.g., the baseline condition), and how is this distribution related to existing habitat conditions (e.g., flow and temperature regimes, human development, restoration actions)?

Comment:

The project indirectly relates to climate change by providing estimates of Mid-Columbia Steelhead abundance that can be associated with climate change indicators. The uncertainty relating to the effect of invasive and nonnative species on the potential recovery of Mid-Columbia Steelhead ESU is directly assessed in the sense that 85% of returning adults are strays, predominately from the Snake River. The report acknowledges that the effect of non-native species is a critical uncertainty. The data on the distribution and abundance of these strays could be associated with data on flow and temperature regimes. The returning adult abundance data could be useful in a complete examination of density dependence, but this activity is not included in the scope of the project.

The project may inform uncertainties based on the data collected and the overall viability of listed steelhead as a result of restoration activities. A critical uncertainty mentioned in the report is the effects of non-native species on recovery of salmonids in the subbasin, especially in lower portion of system.

Methods: Standard methods for fish and habitat assessments are used.

Program relevance and brief summary of findings (research):

There is some potential for steelhead spawning and juvenile rearing in selected areas of Rock Creek and Squaw Creek. The effectiveness of restoration activities may be impacted by limited water flow, the occurrence of flooding that impacts sediment distribution, and high rates of steelhead straying into the basin. It is not clear what the effects of water withdrawals and water depletion in the system will have on salmonid distribution and abundance. More information is available in a recent ISRP review http://www.nwcouncil.org/fw/isrp/isrp2015-6/.

Broad Applicability: Results from this project are limited to the conditions in the Rock Creek subbasin, but the impact on the Mid-Columbia Steelhead ESU is important.

Time Required: If active restoration activities are pursued as part of this project, the time required could be decades. Completion of the habitat assessment should take only a few years.

Deschutes

199404200	Trout Creek Operations and Maintenance (O&M)	Oregon Department of Fish and Wildlife
199802800	Trout Creek Watershed Restoration	Jefferson County Soil and Water Conservation District (SWCD)
200830100	Habitat Restoration Planning/Design/Implementation within boundaries of Warm Springs Reservation, lower Deschutes River, Oregon	Confederated Tribes of Warm Springs
200830600	Deschutes River Fall Chinook Research and Monitoring	Confederated Tribes of Warm Springs
200831100	Natural Production Management and Monitoring	Confederated Tribes of Warm Springs

The five projects within the Deschutes subbasin are diverse by nature, so opportunities for integration/coordination among them were somewhat limited. Two projects on Trout Creek, a major tributary to the Deschutes, were well-coordinated and are working together to complete long-term watershed planning, presumably sharing RME information in the process. Three remaining projects focused on the lower Deschutes. Two of these targeted Confederated Tribes of the Warm Springs Reservation (CTWSR) lands: one examining natural fish production and the other planning, design, and implementation of restoration activities. The annual reports reviewed did not demonstrate coordination between the projects or sharing/application of results/findings between projects. The annual reports provided considerable detail about activities and results for the years in question, and they contained some useful synthesis and retrospective discussion pertaining to previous years. However, annual reporting was not completely up to date as the last reports available on Pisces were for 2013.

199404200 - Trout Creek Operations and Maintenance (O&M)

Links to: project **and** reports

Proponent: Oregon Department of Fish and Wildlife

Province/subbasin: Columbia Plateau/Deschutes

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

Indirect or Potential:

- Fish Propagation: What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles and from harvest in fisheries targeting hatchery-origin adults?
- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?

Comment:

The two Habitat uncertainties listed above are directly addressed.

Since the current work merely tracks trends and does not provide any controls, results will likely have somewhat limited value to resolve uncertainties.

No annual reports for activities in 2013 or 2014 were found. The current 2012 report does provide some information and insights for past project work. The 2013 Geographic Review conducted by the ISRP had a Qualification, "prior to contracting the sponsors should evaluate monitoring data and provide a summary of conclusions. This should be done for each discrete area of monitoring and integrated findings provided for the full suite of past monitoring. A protocol for monitoring vegetative or riparian area should be specified. Also a protocol for monitoring the response to restoration by non-salmonids, such as reptiles and amphibians, should be described." So far a response containing this additional information has not been made.

The monitoring portion of the project, as described in the 2012 report, is comprised of three major components. These include: Tributary Habitat RME (monitor the progress of riparian vegetation and stream channel complexity using photo points and stationed cross-sections); Project Implementation and Compliance RME (photo point, cross section and longitudinal profile surveys to assist in determining the most effective restoration techniques to assist in adaptive management) and Fish Population Status RME (annual estimations of adult spawning and summer steelhead smolt outmigration; metrics including numbers, timing, age at outmigration, size and condition factor, and predation/disease indicators).

Methods: There was no description of specific methodologies used for Tributary Habitat and Implementation compliance RME components. Activities included photo points and stationed, cross sections and longitudinal profile surveys. A variety of generally standard methods and basic analysis techniques are provided for the Fish Population Status RME component. Some results were reported, and most included confidence limits.

Program Relevance and Project Results: Some results and rudimentary lessons learned were reported. It is stated that one of the monitoring goals was to help identify the most effective restoration techniques to assist in adaptive management and also to better understand the population response to the large habitat improvement investment. No program or project restoration objectives are provided. Given that the project has been underway for many years and that there has been more than 100 miles of streams treated and several passage obstructions removed, there is very little indication as to how successful the techniques have been or whether any conclusions could be made on increases in fish production tied to restoration. There are some interesting results in the fish monitoring, but there is limited linkage to how they might inform changes in management.

Broad Applicability: There are some general conclusions and potential findings that could have relevance to other project areas; however, the majority of RME work relates to the Trout Creek watershed. There may be some applicability for results to other East side tributaries of the Deschutes River.

Time Required: It is not clear whether there has been a previous summary of RME results for this project. It appears that given the amount of time and the extent of restoration work that has been implemented, that a more complete reporting of results as related to RME goals and objectives should be provided in the very near future. At this point, it seems unclear as to how continuing all RME elements into the future will provide any new insights or conclusions regarding the project or future management.

199802800 - Trout Creek Watershed Restoration

Links to: project and reports

Proponent: Jefferson County Soil and Water Conservation District (SWCD)

Province/subbasin: Columbia Plateau/Deschutes

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Comment:

There are no critical uncertainties that are directly addressed by reported activities. The last several annual reports, including 2014, are primarily a listing and description of completed restoration projects. There are some good before/after photo sequences for projects, but there is very limited evaluation of the photo series, over time, to determine whether projects accomplished what they were designed to in an expected period of time. There was no quantitative, restoration objectives provided for any of the projects. There is no apparent data storage, analysis, or regular reporting of results and no specific contributions for resolution of key uncertainties.

Work on Trout Creek Restoration is done cooperatively between ODFW and the Jefferson County SWCD. Four annual reports were reviewed for Jefferson County SWCD. None of these reports had a section dedicated to RME activities. There was limited pre/post information provided. Some projects had good before/after photo series provided. There was also use of before/after channel cross sections for another project but no discussion of results or success at meeting project objectives was provided. There is limited discussion regarding post project, field reviews on some projects.

Overall, there does not appear to be a formal RME program including a consistent approach for implementation monitoring. For a project that has been operational for 15 years, the lack of meaningful RME results/findings and their application to improve future restoration, is surprising. It was noted in the latest ISRP review (2013), that one of the major drawbacks to the project is a lack of a clear and comprehensive discussion of the RM&E program. The review goes on to say, “Additionally, adaptive management and effectiveness monitoring need to be modified to provide feedback information for program operation and project location and design.” There are no indications in the Annual Reports that this is occurring.

Methods: Methods are not discussed.

Program Relevance and Project Results: There is a very limited presentation of monitoring information, results, and conclusions. The only indication that monitoring results are being used for adaptive management is a brief discussion on riparian planting techniques. The Lesson Learned section of the most recent annual report covered administrative rather than scientific issues.

Broad Applicability: Local use only.

Time Required: This is an ongoing restoration project.

200830100 - Habitat Restoration Planning/Design/Implementation within boundaries of Warm Springs Reservation, lower Deschutes River, Oregon

Links to: project **and** reports

Proponent: Confederated Tribes of Warm Springs

Province/subbasin: Columbia Plateau/Deschutes

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

Comment:

Three critical uncertainties are listed that project data could potentially inform. However, the reports provided offered a very limited view of ongoing RME activities, particularly data summary, evaluation, and linkage to ongoing management and restoration activities.

An annual report was not found for 2014. The 2013 Report covers habitat restoration program activities within the boundaries of the Warm Springs Reservation. The most recent ISRP reviews established qualifications to the program that included a request for more details about the habitat project monitoring efforts and further noted, “Each project site should have its own monitoring and evaluation plan, as the specific restoration actions will vary from place to place …” The current annual report covers work from 3/13 to 2/14 and references three specific RME activities for riparian protection projects (Riparian Protection Status report 2013 uploaded to Pisces), active restoration projects and fine sediment (historic sediment data report updated in 2013 and uploaded to Pisces).

Methods: There is limited discussion in the annual report regarding specific methods or evaluation of the precision and accuracy of data. It was noted that for riparian projects and fine sediment that data and monitoring reports were updated. There was no additional information provided other than a note that these reports had been uploaded to PISCES. They were not located.

Program Relevance and Project Results: RME activities are primarily focused on assessing project level activities and appear to include implementation and effectiveness monitoring components. There is no discussion of probable linkages and coordination with AEM, CHaMP, or ISEMP program activities. There is no discussion regarding how monitoring is contributing to adaptive management of the project or any linkages to the Natural Fish Production Management and Monitoring project (2008-311-00) also being conducted on CTWS lands.

Broad Applicability: RME activities are primarily focused on project level activities. They appear most relevant to local conditions but may have general relevance to similar restoration treatments in the other mid-Columbia tributaries.

Time Required: It does not appear that activities will be completed in a 3 to 5 year time frame. There is no discussion of time frames or likely schedules for completion of current RME activities.

200830600 - Deschutes River Fall Chinook Research and Monitoring

Links to: project **and** reports

Proponent: Confederated Tribes of Warm Springs

Province/subbasin: Columbia Plateau/Deschutes

2006 Research Plan uncertainties addressed:

Direct:

- Harvest: What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?

Indirect or Potential:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Harvest: What new harvest and escapement strategies can be employed to improve harvest opportunities and ecological benefits within the Columbia Basin while minimizing negative

effects on ESUs or populations of concern? Can genetic techniques be used to quantify impacts on wild or ESA-listed stocks in ocean fisheries?

Comment:

This tagging and monitoring project directly addresses the 2006 critical uncertainty about the effect and management of fishery interceptions and harvest in mixed-stock areas. The Deschutes River fall Chinook population is an indicator stock for the Pacific Salmon Commission and information from this project is used to set harvest rates in mixed-stock coastal fisheries to sustainably manage other fall Chinook populations.

In conjunction with other efforts, the project could indirectly help to address additional 2006 uncertainties related to strategies to improve harvest opportunities and ecological benefits; the effects of tributary habitat restoration on survival, productivity and abundance; and habitat protection and restoration needed for long-term viability.

Methods: Survey, tagging, and mark-recapture methods seem standard and appropriate and include aerial counts by helicopter and carcass recovery by jet boat. Abundance downstream of Sherars Falls is not estimated so the ratio of redds counted below and above the Falls is multiplied by the mark-recapture population estimate above the Falls to generate a below Sherars Falls escapement estimate. A potential concern is the adequacy of ground-truthing of aerial surveys.

Program Relevance and Project Results: This monitoring project is developing aerial redd and carcass surveys to improve escapement estimates of fall Chinook in the Deschutes River and is PIT-tagging juvenile Chinook to monitor smolt-to-adult survival. Deschutes River fall Chinook are one of the indicator stocks identified by the Pacific Salmon Commission (PSC) to manage Pacific Coast ocean and river harvest of Chinook salmon.

Adult fall Chinook were PIT-tagged at Bonneville Dam and recaptured or detected at other locations within the Columbia River Basin to determine escapements of Upriver Bright Chinook in three primary areas of production: Hanford Reach, the Deschutes River, and the Snake River.

Reporting: The last annual report available on Pisces was for 2013. It provided considerable detail about activities and results for the year in question, and some synthesis and retrospective discussion pertaining to previous years.

Broad Applicability: Results from this project apply primarily to the Deschutes population, but this population is a wild indicator stock for coast-wide management of Chinook fisheries by the PSC.

Time Required: The project began monitoring escapements in 2009 and began tagging juveniles in 2011. Monitoring will likely be required indefinitely to assess fisheries impacts on indicator stocks.

200831100 - Natural Production Management and Monitoring

Links to: project **and** reports

Proponent: Confederated Tribes of Warm Springs

Province/subbasin: Columbia Plateau/Deschutes

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Population structure and diversity — What approaches to population recovery and habitat restoration are most effective in regaining meta-population structure and diversity that will increase viability of fish and wildlife in the Columbia River Basin?

Comment:

This monitoring project provides baseline data about the distribution and abundance of natural spawning populations of spring Chinook and summer steelhead in the lower Deschutes River. The project, by itself, does not directly address any of the 2006 Research Plan critical uncertainties. However, the availability of accurate time series of escapement data could potentially contribute to resolving uncertainties involving productivity, carrying capacity, and spatial diversity of fish populations.

Methods: Methods seem appropriate and were reviewed favorably by the ISRP (2012). Monitoring includes video enumeration of returning adults to each stream basin, redd counts for both species, trapping of juvenile outmigrants (smolts) in the spring (March – June) and the fall (October – December) using rotary screw traps, and snorkel surveys to determine the relative densities of juvenile Chinook salmon and *O. mykiss*. Snorkel survey methods were improved in 2012 to obtain more precise estimates of juvenile abundance and egg-to-parr survival.

Program Relevance and Project Results: This project is monitoring production of naturally produced spring Chinook salmon and summer steelhead in Reservation streams tributary to the lower Deschutes River. Specific objectives include verification of species distribution, adult escapement, spawning surveys, juvenile outmigration and abundance, and development of management strategies and goals. The proportion of hatchery-origin fish among naturally spawning spring Chinook in Shitike Creek has averaged 22% (range 7% to 55%) from 2004-2012.

Reporting: The last annual report available on Pisces was for 2013. It provided considerable detail about activities and results for the year in question and good synthesis and retrospective discussion pertaining to previous years.

Broad Applicability: Results from this project apply only to spring Chinook and summer steelhead in the lower Deschutes River.

Time Required: This ongoing monitoring and evaluation project began monitoring adult escapements in 2009 but has extended a time series that started in 1980.

John Day

199801600	Escapement and Productivity of Spring Chinook and Steelhead	Oregon Department of Fish and Wildlife
200001500	Oxbow Conservation Area	Confederated Tribes of Warm Springs
200104101	Forrest Conservation Area	Confederated Tribes of Warm Springs
200739700	John Day Watershed Restoration	Confederated Tribes of Warm Springs

Summary

Substantial monitoring is being conducted in the John Day subbasin that could potentially be used to address uncertainties. However, the monitoring efforts would be more effective if study design and methods were better linked to restoration objectives and actions, and in some cases, if reporting was improved. Integration of monitoring across the subbasin is needed to result in cost-effective evaluation of restoration actions.

199801600 - Escapement and Productivity of Spring Chinook and Steelhead

Links to: project **and** reports

Proponent: Oregon Department of Fish and Wildlife

Province/subbasin: Columbia Plateau/John Day

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?

Indirect or Potential:

- Fish Propagation: What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles and from harvest in fisheries targeting hatchery-origin adults?

Comment:

This status and trend monitoring project tracks summer steelhead and spring Chinook populations across the John Day River basin. Six metrics are examined: (1) spawning escapement of adult summer steelhead *Oncorhynchus mykiss* in the South Fork John Day River population, (2) origin (hatchery or wild) of adult summer steelhead in the entire John Day River basin, (3) summer rearing density of *O. mykiss* in the South Fork and Middle Fork populations, (4) out-migrant abundance of summer steelhead and spring Chinook *O. tshawytscha*, (5) productivity (recruits per parental spawner) of select summer steelhead and spring Chinook populations, and (6) smolt-to-adult ratios (SAR) for summer steelhead and spring Chinook describing survival through Columbia River and Pacific Ocean life history phases.

Methods: This research effort employs a statistically based and spatially explicit sampling design to answer key monitoring questions. Currently the sampling strategy of the United States Environmental Protection Agency's (EPA) Environmental Monitoring and Assessment Program (EMAP) is being used, following recommendations by the ISRP to move away from index surveys and embrace probabilistic sampling for most population and habitat monitoring. There is general discussion on the accuracy and potential limitations for the data, as well as expectations for more complete analyses with longer time frames and samples sizes. There are succinct descriptions of findings and discussion of their relevance to the monitoring objectives.

Program Relevance and Project Results: This project is status and trend monitoring for summer steelhead and spring Chinook populations for the entire John Day River basin. Key findings include the identification of an apparent density-dependent influence on steelhead smolt production in both populations (South Fork and Middle Fork). Results also indicate a negative relationship exists between smolts per spring chinook redd and the total number of redds, suggesting a density dependent regulation on the population. Also, the report indicated that a decrease in the percentage of hatchery steelhead in the John Day coincided with a decrease in the percentage of hatchery steelhead barged from Lower Granite Dam. The report concludes that reducing the number of smolts being barged is an effective technique for controlling steelhead straying.

Broad Applicability: Results provide information that can be used at various scales (basin and subbasin) within the John Day. Data and preliminary results appear to be linked to initial research questions with direct applicability to future management and restoration work. It is anticipated that continuation of current work will support life cycle modeling for the basin and will be linked to CHaMP data to make determinations relative to the success of protection and restoration actions.

Time Required: This is a long-term status and trend monitoring project. It appears that findings relevant to the monitoring questions are being provided and are linked to the amount of sampling across the basin and the duration of the datasets**.**

200001500 - Oxbow Conservation Area

Links to: project **and** reports

Proponent: Confederated Tribes of Warm Springs

Province/subbasin: Columbia Plateau/John Day

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Comment:

This project is focused on habitat restoration and protection, rather than research or monitoring and evaluation. Although some data from this project could help address critical uncertainties with habitat restoration and protection effectiveness, it is not clear how much of this is occurring. The 2013-2014 Annual Report summarizes the property management tasks completed by this project including facility maintenance, weed control, fence repair, environmental compliance, implementation of grazing leases, and provision of public access. Some project level monitoring and evaluation is included, namely, redd counts, snorkel surveys, Conservation Reserve Enhancement Program (CREP) surveys, vegetation monitoring, photo points, weather station data collection, stream flow gauging, and temperature logging.

Methods: Methods are not described in detail, and the project proponent describes difficulty entering and selecting protocols in MonitoringMethods.org. This is a programmatic issue that the ISRP should investigate.

Program Relevance and Project Results: Observations by the project proponent indicate that browse enclosure fences, weed control, and grazing rotations are working, but quantitative results are not included in the annual report. The results of the steelhead redd survey are reported in the text, but the results are not tied to objectives or put in the context of previous year counts, which would be useful to include in annual reports for this project. Results of the snorkel survey need to be described. The temperature data are transferred to the IMW database.

Project staff work with ODFW to conduct Spring Chinook surveys along the Middle Fork John Day River: "Unfortunately there was a big fish kill in early July of 2013 due to warm instream temperatures so there weren't as many redds later on in the summer. In total there were 113 redds found on the Middle Fork and 36 of them were on the OCA [Oxbow Conservation Area] or 32% of the total." That appears to be a high percentage of redds attributed to the project area within the Middle Fork, but the annual report does not describe what that means in the context of the project or the Middle Fork in general.

Broad Applicability: It is not clear whether the practices are broadly applicable because monitoring results are not linked to practices.

Time Required: This is an ongoing habitat protection and restoration project. Results need to be reported and disseminated more broadly and in a timely manner.

200104101 - Forrest Conservation Area

Links to: project **and** reports

Proponent: Confederated Tribes of Warm Springs

Province/subbasin: Columbia Plateau/John Day

2006 Research Plan uncertainties addressed:

The project does not address any of the 2006 Research Plan uncertainties.

Comment:

This project is implementing a number of projects within the Mainstem Forest Conservation Area (MSFCA) and the Middle Fork Forrest Conservation Area (MFFCA) of the John Day. Some projects are water conservation and habitat restoration oriented, while others are facilities related.

Methods: Some field monitoring data are collected, including fish, habitat, and flow for some (e.g. grazing study) of the sites, focal species are lamprey, chinook, steelhead, and bull trout. However, the actual data presented in this report are limited, and no robust study design is presented.

The Tribes are attempting to get their methods and content disseminated. A better articulated and focused dissemination plan is needed to ascertain whether data produced by the project can be used by others. That may be problematic because of the site-specific nature of the project.

Like other reports, this group reports issues and delays with trying to get their monitoring methods posted on monitoringmethods.org.

Program Relevance and Project Results: The annual report covers many tasks that are not directly related to recovery (e.g. new well for the office, new office building, etc.). Therefore much of the annual report information is not amenable to evaluating the effectiveness of restoration actions.

Broad Applicability: This project is very site specific.

Time Required: This is an ongoing habitat protection and restoration project. Reports are submitted in a timely manner.

200739700 - John Day Watershed Restoration

Links to: project **and** reports

Proponent: Confederated Tribes of Warm Springs

Province/subbasin: Columbia Plateau/John Day

2006 Research Plan uncertainties addressed: None

Comment:

There has not been an annual report for this project since 2010. The last updates for the project are from 2013 and are field tour notes. Based on the 2010 report, the project was funded to help support watershed restoration plans and evaluate specific actions using models. Some actions were implemented, ranging from changing diversions and pumping stations, culvert replacements, riparian fencing and revegetation, etc. It was not clear, however, who implemented the projects. No data are provided in the2010 report. A few of the habitat projects appear to have some limited monitoring (e.g., photo points, vegetation plots).

The project was evaluated by the ISRP in the 2013 Geographic Category Review. In their review the ISRP noted: "Restoration actions undertaken so far by this project are primarily passage improvement, juniper removal, riparian planting, LWD placement, and installation of cattle exclosures. Results consist primarily of descriptions of projects that have been undertaken to date. Few quantitative results were presented. The proposal could have been improved if the sponsors had discussed in more detail what sort of M&E program is currently in place, what kind of monitoring data have been collected, and whether the data have been analyzed and utilized." The ISRP recently received documents that respond to their 2013 review qualification. These materials are currently under review and a response by the ISRP is expected in early 2016.

At present, it is unclear whether the project is producing knowledge that can help resolve any of the uncertainties in the 2006 Research Plan. The documents recently submitted to the ISRP and future annual reports, however, will help answer this question.

Umatilla

200901400	Biomonitoring of Fish Habitat Enhancement	Umatilla Confederated Tribes (CTUIR)
198710001	Umatilla Anadromous Fish Habitat-Umatilla Tribe	Umatilla Confederated Tribes (CTUIR)
198710002	Umatilla Anadromous Fish Habitat-Oregon Department of Fish and Wildlife (ODFW)	Oregon Department of Fish and Wildlife
198802200	Umatilla Fish Passage Operations	Umatilla Confederated Tribes (CTUIR)

Summary

This set of projects describes efforts to restore habitat and connectivity for anadromous salmonids and lamprey in the Umatilla River, a mid-Columbia tributary. Actions include removing irrigation diversions that block fish passage, operating fish ladders and bypass facilities that maintain passage over other diversions, reconnecting floodplain habitats to enhance hyporheic flows that provide cool water in summer, completing plantings and fencing in riparian areas, and creating rock and wood structures to provide additional habitat.

The efforts are all relatively early in their development and will require monitoring to determine whether they were installed as planned and cause expected changes in habitat. Other projects in the basin will monitor effects of this habitat restoration on fish populations.

It was unclear from the set of reports whether the different groups conducting the work coordinate toward common restoration goals, although most projects are conducted by the same proponent (CTUIR). Nevertheless, it would be ideal if the efforts could be integrated, and if annual reports could discuss this integration.

200901400 - Biomonitoring of Fish Habitat Enhancement

Links to: project **and** reports

Proponent: Umatilla Confederated Tribes (CTUIR)

Province/subbasin: Blue Mountain/Grande Ronde, Columbia Plateau/John Day, Columbia Plateau/Tucannon, Columbia Plateau/Umatilla, Columbia Plateau/Walla Walla

Note: this project submitted an annual report in August 2015, but the ISRP and ISAB conducted its review of annual reports in May-July 2015. Thus, additional information is now available that was not considered when developing these comments.

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Comment:

If successful, this project would directly address the critical uncertainty listed.

Methods: This is an Accord project that proposed an ambitious plan for monitoring the effects of habitat restoration projects in the Grande Ronde, John Day, Tucannon, Umatilla, and Walla Walla subbasins on spring Chinook salmon, summer steelhead, and bull trout. A draft August 2012 report details hypotheses, experimental designs, and analysis methods, and sampling methods. Hypotheses about effects of restoration actions on juvenile fish density, survival, residence time, growth rates, and distribution are detailed, and BACI or Before/After experimental designs and statistical models are defined. Life-cycle modeling is proposed as a key component to measure effects at watershed scales over longer time periods, and several alternative models are considered.

Program Relevance and Project Results: If successful, the project could be highly relevant because it integrates results of restoration across many subbasins and across entire life cycles. However, no data have yet been collected, and no reports have been finalized, so no findings are available [see note above].

Broad Applicability: If successful, the results could have broad applicability because of the broad spatial and temporal scale.

Time Required: This biological monitoring is likely needed for a 10-year duration.

198710001 - Umatilla Anadromous Fish Habitat-Umatilla Tribe

Links to: project **and** reports

Proponent: Umatilla Confederated Tribes (CTUIR)

Province/subbasin: Columbia Plateau/Umatilla

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

Comment:

The relation of the project to the critical uncertainties identified is distinctly indirect. This project funds habitat restoration, the effects of which could be monitored by other projects to address critical uncertainties.

Methods: This habitat restoration project in the Umatilla River subbasin involved removing three irrigation diversions that were barriers to fish passage, reconnecting a channel to its floodplain in an important tributary, construction of rock and large wood structures to increase channel complexity, and vegetation plantings for floodplain restoration. A macroinvertebrate study was also conducted, in a BACI design. In addition, the proponents are working cooperatively with Montana State University researchers to measure and model hyporheic flow paths before and after the Meacham Creek Floodplain Restoration project. Restoration is predicted to increase hyporheic flow and upwelling, and thereby moderate temperatures for listed fish (see project 2007-252-00). Outreach and education was conducted via field tours and presentations at local, regional, and national workshops and meetings.

Program Relevance and Project Results: The goal of this project is to restore physical and biological processes necessary to sustain CTUIR First Foods, including Chinook salmon, steelhead, bull trout, and lamprey, and to restore species listed under the ESA. For example, maximum water temperatures throughout the accessible portions of the subbasin often exceed lethal limits for bull trout, and approach them for Chinook salmon and steelhead. Removing three diversions allowed access to 7.7 miles of upstream habitat to adult spawners. A total of 10 conservation easements were maintained in riparian areas, and a major project to restore native shrubs and grasses was conducted on 2.3 miles in one tributary that provides important spawning and rearing habitat (Meacham Creek). At Meacham Creek, baseline water quality and sediment monitoring were conducted at the mouth, CHaMP baseline monitoring of habitat was conducted, photos were taken before and after the floodplain was reconnected, and pre-restoration data on macroinvertebrates was measured and analyzed. Early results from the model of hyporheic flow for this reach are promising. Measuring the effects of restoration on fish is not part of the project.

Additional critical uncertainties: This project represents many disparate activities, which have evolved over time. A key uncertainty is whether such disparate collections of activities can be reassembled into a focused monitoring program to address critical uncertainties of interest.

Broad Applicability: Results may be applicable to restoration in other similar mid-Columbia River tributaries.

Time Required: More years of sampling will be required to determine the full effects of restoration on physical and biological attributes. So far, only pre-treatment data have been collected and analyzed.

Quality of annual report: The annual report was laid out by work element, but key information was not so easy to find. A clearer structure of problem statement, methods, results, and discussion could be more effective for conveying information to readers.

198710002 - Umatilla Anadromous Fish Habitat-Oregon Department of Fish and Wildlife (ODFW)

Links to: [project]() **and** [reports]()

Proponent: Oregon Department of Fish and Wildlife

Province/subbasin: Columbia Plateau/Umatilla

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Mainstem Hydrosystem Flow and Passage Operations: What are the optimal temperature and water quality regimes for fish survival in tributary and mainstem reaches affected by dams, and are there options for hydrosystem operations that would enable these optimal water quality characteristics to be achieved? What would be the effects of such changes in operations and environment on fish, shoreline and riparian habitat, and wildlife?

Comment:

The relation to the critical uncertainties is distinctly indirect, because this habitat implementation project is conducting habitat improvement rather than research, monitoring, or evaluation. The effects of these improvements on physical conditions and fish could be tested later to address the critical uncertainties listed.

Methods: The work consists of removing fish passage barriers (irrigation diversions) in tributaries of the Umatilla River, monitoring temperature and flow at key locations, planting native riparian plants, killing noxious weeds, and maintaining riparian fencing to prevent damage by livestock. Outreach and education were also conducted.

Program Relevance and Project Results: The project is implementing habitat restoration in tributaries of the Umatilla River to improve floodplain habitats for spawning and rearing salmonids and provide passage for adults into suitable upstream tributary habitats for spawning and rearing of juveniles. Flow and temperature are monitored to determine whether habitats are suitable. Overall, four passage barriers have been removed since 2010, and one more is planned for removal, which increases access to upstream suitable habitats by Chinook, coho, steelhead, and other native fish species. Fences were repaired and noxious weeds controlled on 10 riparian and stream restoration projects (e.g., 151 instream structures were created and are maintained), and native trees and shrubs were planted at three properties. Outreach presentations were given at six different venues.

Broad Applicability: This project is applicable to the Umatilla River subbasin, but lessons learned could be applied to other similar subbasins.

Time Required: The project is ongoing, with more work planned, but an end date is unclear.

Quality of annual report: The annual report is succinct and well written, and the information needed to address critical uncertainties was easy to find.

198802200 - Umatilla Fish Passage Operations

Links to: project **and** reports

Proponent: Umatilla Confederated Tribes (CTUIR)

Province/subbasin: Columbia Plateau/Umatilla

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Climate Change: What long-term changes are predicted in the Columbia River Basin and the northeast Pacific Ocean, how will they affect the fish and wildlife in the region, and what actions

can ameliorate increased water temperatures, decreased summer river flows, and other ecosystem changes?

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Human Development: How might the projected changes under different development scenarios affect land use patterns, protection and restoration efforts, habitats, and fish and wildlife populations?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What are the optimal temperature and water quality regimes for fish survival in tributary and mainstem reaches affected by dams, and are there options for hydrosystem operations that would enable these optimal water quality characteristics to be achieved? What would be the effects of such changes in operations and environment on fish, shoreline and riparian habitat, and wildlife?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?

Comment:

This project consists of operation and maintenance of fish passage facilities in the lower Umatilla and Walla Walla river subbasins, and so the relation to the critical uncertainties is distinctly indirect. That is, the project is collecting data that could be used to inform the uncertainty in the future.

Methods: Project number 2000-033-00 was re-combined with 1988-022-00 in 2014, so recent annual progress reports for both rivers were reviewed. Both projects use standard methods for coordinating operation and maintenance of fish ladders, screen sites, bypasses, trap facilities, and transportation equipment. On the Umatilla River, there is a concern about the ability to accurately identify marks at Three Mile Dam due to inconsistency of mark data between trapping and video periods. On the Walla Walla River, there is uncertainty with regard to methods that will meet passage criteria at the Nursery Bridge Facility.

Program Relevance and Project Results: This effort is for project level monitoring. Water diversions for agriculture in the lower Umatilla River blocked upstream adult migrants and downstream juvenile and adult migrants in the past, and were a major limiting factor for the summer steelhead, spring and fall

Chinook, coho, some bull trout, and lamprey. Habitat restoration has included adult fish ladders for upstream passage at all blockages (except not all have ladders for lamprey), bypass facilities to pass juveniles and adult kelts downstream, and exchanges of water to provide instream flows for fish passage during low summer and winter flows. When flows would be too low for fish passage, water is diverted from McNary Dam Pool on the mainstem Columbia and supplied to irrigation districts, in exchange for leaving water in the river to allow fish passage. Overall, fish passage facilities are apparently working well, based on telemetry conducted by other projects. Fish are monitored and measured as they pass upstream and downstream, and they are trapped and hauled only when necessary (or trapped for hatchery broodstock).

On the Walla Walla River, photographic and visual monitoring is conducted after major weather/flow events to assess and correct fish passage problems. Shifting of the river channel has resulted in numerous unscheduled emergency gravel removal activities. Flow and temperature data are not available on a real-time basis, which limits effective management. Another problem, which may respond to public outreach, is vandalism at some sites and recreational dam building throughout the river during summer.

Broad Applicability: The project provides restoration of connectivity for passage of salmon, steelhead, bull trout, and in some cases lamprey on major tributaries of the mid-Columbia River. Results are applicable to the lower reaches of the Umatilla and Walla Walla rivers. Some improvements to lamprey passage in the Umatilla River have been made, but the effectiveness of these efforts needs additional monitoring.

Time Required: The project is ongoing and must be continued for the foreseeable future to ensure that fish ladders and bypass facilities operate at optimum levels given changes in flow and channel morphology, and that water exchanges are timed to allow fish passage through reaches that would otherwise be dewatered by irrigation diversions.

Quality of Annual Report: The annual report for the Umatilla River was clearly laid out in Objectives and Tasks, and information was easily found.

Walla Walla

200003900	Walla Walla River Basin Monitoring and Evaluation (M&E)	Umatilla Confederated Tribes (CTUIR)
200739600	Walla Walla Basinwide Tributary Passage and Flow	Walla Walla Basin Watershed Council
200902600	Walla Walla Juvenile and Adult Passage Improvements	Umatilla Confederated Tribes (CTUIR)

Summary

In addition to basin-scale status and trend monitoring, site-specific restoration actions in the Walla Walla are supported by BPA. None of the annual reports that we reviewed contribute to understanding the effectiveness of restoration actions, though the status and trend project is producing some important results regarding the recovery of listed species.

200003900 - Walla Walla River Basin Monitoring and Evaluation (M&E)

Links to: project **and** reports

Proponent: Umatilla Confederated Tribes (CTUIR)

Province/subbasin: Columbia Plateau/Walla Walla

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?

Indirect or Potential:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- What are the tributary habitat limiting factors (ecological impairments) or threats preventing the achievement of desired tributary habitat performance objectives?

Comment:

This project monitors the abundance, productivity, diversity, and spatial distribution of adults and juveniles in the Walla Walla River basin, with focus on spring Chinook, steelhead, and bull trout. This study also compares hatchery vs. wild populations. Fish measures reported include metrics of adults migrating in (abundance, spawners per redd, redds per km, run timing, adult-to-adult return) and juveniles out (smolt abundance, smolts per redd, run timing and survival, smolt-to-adult return). The proponents are also monitoring discharge and temperature.

Methods: Methods include trapping upstream adult migrants, redd counts, and trapping and PIT tagging downstream juvenile migrants. Adult and juvenile bull trout abundance is estimated by snorkeling, electrofishing, and redd counts. Overall, the methods appear to be sound and provide statistically reliable results, with measures of precision reported. Their methods are described in the document and are posted on monitoringmethods.org, with some modifications to methods underway.

Program Relevance and Project Results: The program collaboratively monitors trends of salmonids to assess habitat and watershed restoration efforts. Overall, the reintroduced Chinook population is showing signs of rebuilding and is considered successful but not fully seeded. A primary limit may be factors outside the basin, in the mainstem, estuary, and ocean. Of the two steelhead populations, the Walla Walla River population is appearing to meet recovery goals for production and survival is increasing. In contrast, the Touchet River steelhead population is apparently not replacing itself, but there are major data gaps downstream of monitoring weirs where production is not known. Bull trout are showing signs of increasing abundance, especially for redd counts, but monitoring efforts are not yet sufficient to measure trends.

In addition to the goal of collecting status and trend data, the project aims to "provide ecological information to decision makers in support of adaptive management for ESA recovery/conservation, population restoration, and preservation of cultural, social, and economic resources," including evaluating the effect of a variety of river restoration practices (e.g. instream flow enhancement, fish passage improvement, floodplain restoration, and hatchery reintroduction/supplementation) on fish. However, it is not clear that the study design is sufficient to link fish response with the restoration practices or establish causality. While it is not clear that this project actually addresses the effectiveness of individual actions, analysis (to be conducted) may provide insight into how a basinwide program of restoration impacts populations.

The scale of the effort is most of the watershed, although there are data gaps for adults that spawn below monitoring weirs.

Broad Applicability: This project is broadly applicable to status and trend monitoring for three listed species in the mid-Columbia. However, the ability to inform effectiveness of actions is limited since there is no means for assessing causality associated with the actions.

Time Required: These efforts will be required for the foreseeable future to estimate status and trends for the three listed salmonids. The authors argue that they need additional monitoring, including more time and more methods (e.g. PIT array sites, video monitoring) to provide baseline status for bull trout and continued monitoring of steelhead and spring Chinook. Project reports have been timely. Data from the project are reported on data repositories.

200739600 - Walla Walla Basinwide Tributary Passage and Flow

Links to: project **and** reports

Proponent: Walla Walla Basin Watershed Council

Province/subbasin: Columbia Plateau/Walla Walla

2006 Research Plan uncertainties addressed: None

Comment:

This restoration project does not address uncertainties and, based on the FY 2014 annual progress report, does not appear to contribute to project-level monitoring.

Program Relevance and Project Results: The progress report focuses on estimating benefits of piping the two remaining open ditches. Under this contract, the authors worked to establish benefits and feasibility of piping two open canals. The key finding is that the benefits are about 1/2 (2.5 cfs) of their original estimate (3.8-4.5 cfs). They also had trouble securing buy-in from the stakeholders and thus have put the project "on hold" because the streamflow savings do not meet minimum criterion of 1 cfs/$500k set by the funding agency (WA State Conservation Commission’s Irrigation Efficiency Grant Program). The proponents argue that the pipeline is still worthwhile from a water quality perspective, but evidence supporting that contention needs to be provided.

The progress report lists previous water saving projects but does not summarize the benefits to fish and wildlife resulting from the project.

Broad Applicability: None. Results are project specific only.

Time Required: This is an ongoing habitat restoration project. The timeline for reporting is appropriate.

200902600 - Walla Walla Juvenile and Adult Passage Improvements

Links to: project **and** reports

Proponent: Umatilla Confederated Tribes (CTUIR)

Province/subbasin: Columbia Plateau/Walla Walla

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Comment:

This project monitors the operations of a fish screen on the Walla Walla, constructed in 1999, to evaluate whether fish might be affected by approach velocities. Monitoring questions centered on:

- Are screens designed, operated, and maintained to meet NMFS criteria standards over a wide range of conditions?
- Do velocities and flows meet NMFS criteria standards?
- Are screens effective at protecting fish from injury and from unnecessary migration delay?

This project does not appear to contribute to any broader uncertainties.

Methods: Methods include velocity measurements using an Acoustic Doppler Velocimeter (ADV) at 0.2 and 0.8 depths, video inspection, and general site information (e.g. screen conditions, debris, fish presence, cleaning system operation). Results indicate the fish screen is operating in compliance with NMFS regulations but that debris accumulation is an issue at the site and limits the screening area.

Regarding adaptive management, the authors also found that herons were observed at the canal and that it should be replaced with a closed pipe to reduce predation.

Program Relevance and Project Results: This is a project-level monitoring project.

Broad Applicability: Limited. Results are site specific.

Time Required: It is not clear how long the screens will need to be monitored for compliance, but continued site inspections will be needed to check screen conditions and accumulation of debris. Results are generated in a reasonable timeframe.

Yakima

201003000	Project to provided VSP Estimates for Yakima Steelhead MPG	Yakama Confederated Tribes
199603501	Yakama Reservation Watershed Project	Yakama Confederated Tribes
199206200	Lower Yakima Valley Riparian Wetlands Restoration	Yakama Confederated Tribes

201003000 - Project to provided VSP Estimates for Yakima Steelhead MPG

Links to: project **and** reports

Proponent: Yakama Confederated Tribes

Province/subbasin: Columbia Plateau/Yakima

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?
- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?

Comment:

In general, much useful information was generated, but it is unclear how useful the information will be beyond the Yakima. Monitoring is likely to be ongoing, especially because of the time needed to develop relationships.

This is a status and trend monitoring project for the Upper Yakima steelhead population group. An additional focus of the work relates to resident/anadromous interactions studies associated with the Yakima Steelhead Viable Salmonid Population (VSP) Project. The project is funded under two BPA contracts, one for the Yakama Nation and the other for the Washington Department of Fish and Wildlife (WDFW). The WDFW contract work focuses on the Upper Yakima Steelhead population, and the current report was completed by the Washington Department of Fish and Wildlife in collaboration with the Yakama Nation. Primary VSP metrics, most desired from a status and trend monitoring standpoint of the upper Yakima steelhead population, include abundance, productivity, spatial structure, and diversity.

Methods: There is discussion regarding the accuracy and precision of the data and analyses conducted as well as thoughts on improvements that could be implemented in the future. Examples of this include a discussion regarding complications in estimating these VSP metrics and methods for addressing the uncertainty associated with the interactions between anadromous and resident life history forms. Additionally there is discussion regarding improving detection capability of the PIT tag interrogation system through minor equipment reconfiguration and more consistent troubleshooting to identify and reduce ambient noise.

Program Relevance and Project Results: The project is providing both qualitative life history information and quantitative data regarding abundance and productivity as tied to recovery goal objectives. The report notes that data collection activities are tracking progress towards meeting the documented recovery goals. Some examples of reported findings include the following:

Adult natural and hatchery origin adults: It appears that the adult steelhead returns to the Yakima major population group (MPG) are faring well relative to other regions throughout the Columbia Basin and that preliminary observations suggest that anadromous steelhead run escapement in the upper Yakima has generally been increasing.

Juvenile Abundance and Productivity: Data suggest that there appears a high degree of overlap in the rearing distribution of anadromous and resident *O. mykiss* during the rearing period. Also, all five of the core, long term, monitoring tributary streams have abundance trajectories with positive slopes, three of which are statistically significant.

Spatial Distribution: Monitoring to date suggests *O. mykiss* spatial distribution remains stable in the Upper Yakima and substantial change in utilization trends has not been detected.

Diversity: There is enormous variability of *O. mykiss* diversity metrics. Recent work suggests that *O. mykiss* can spawn during any month of the year in different locales, and that appears to be driven in large part by environmental factors.

Some research is identified: “One of our objectives in monitoring steelhead status and trends in population abundance is to use our PIT tag infrastructure to determine the spatial distribution and abundance of adult steelhead spawners in the Upper Yakima population. The radio telemetry study was used to validate the use of our PIT tag infrastructure to estimate the steelhead spawning distribution and abundance by tributary. For adult spawner abundance in the upper Yakima, detections of radio tagged adults (that are also PIT tagged) at our PIT tag arrays are compared to the radio-telemetry mobile tracking detections that have been conducted routinely to determine the detection rate of the PIT tagged individuals at the fixed monitoring sites.”

Sample sizes of these two groups of fish provided in Table 1 of the annual report.

Result of this comparison: They are in the second year of the comparison between PIT tagged and telemetered fish. “The annual run of wild adult steelhead migrating upstream from Roza Dam was estimated to be 376 during the 2014 spawning migration (www.YKFP.org). Radio Telemetry monitoring indicated that of the 68 radio-tagged steelhead tracked to their 9 spawning locations, 69% were in tributaries, and 31% were located in the main stem Yakima River upstream from Roza Dam.”

Broad Applicability: The information is specific to the upper Yakima, wild winter steelhead populations. General findings in this project may provide insights into life history, abundance, and productivity of steelhead populations in other subbasins and potentially could guide planning and contribute to effectiveness monitoring of habitat restoration activities at a watershed scale. The authors claim “One of the secondary benefits is that the data are collected in a manner to answer critical uncertainties associated with the interactions of life history types in this sympatric population.”

Time Required: This is a long term project. As noted in the report, “… generating robust VSP estimates takes considerable time. For example, NOAA recommends collecting a minimum of 12 years of spawner abundance data to generate robust productivity estimates. Data collection efforts under this project began in 2011 and we acknowledge that we are early in the data collection activities relative to the desired time series of data to generate these metrics.” They've been monitoring since 1993, and they make crude prediction of time until recovery as 2041. See Fig. 3 of the annual report for trends in abundance over time; generally positive.

199603501 - Yakama Reservation Watershed Project

Links to: project and reports

Proponent: Yakama Confederated Tribes

Province/subbasin: Columbia Plateau/Yakima

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Climate Change: What long-term changes are predicted in the Columbia River Basin and the northeast Pacific Ocean, how will they affect the fish and wildlife in the region, and what actions can ameliorate increased water temperatures, decreased summer river flows, and other ecosystem changes?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Monitoring and Evaluation (adaptive management): Make best professional judgment, based on available data, as to whether any new research in the spirit of the Intensive Watershed Monitoring approach should be instigated immediately. Most new intensive research should arise as a result of the interaction of existing inventory data with new data arising in population and habitat status and trend monitoring.

Comment:

This project does not directly research any of the 2006 Research Plan uncertainties, but may provide data that could be used to answer the uncertainties shown above.

199206200 - Lower Yakima Valley Riparian Wetlands Restoration

Links to: project **and** reports

Proponent: Yakama Confederated Tribes

Province/subbasin: Columbia Plateau/Yakima

2006 Research Plan uncertainties addressed:

- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

Comment:

This project does not directly research any of the uncertainties in the 2006 Research Plan, but it may have data that others could use to address these uncertainties.

Tucannon

201007700 - Tucannon River Programmatic Habitat Project

Links to: project **and** reports

Proponent: Snake River Salmon Recovery Board

Province/subbasin: Columbia Plateau/Tucannon

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

Indirect or Potential:

- Climate Change: What long-term changes are predicted in the Columbia River Basin and the northeast Pacific Ocean, how will they affect the fish and wildlife in the region, and what actions

can ameliorate increased water temperatures, decreased summer river flows, and other ecosystem changes?

- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Monitoring and Evaluation (adaptive management): Can a scientifically credible trend monitoring procedure based on remote sensing, photography, and data layers in a GIS format be developed?

Comment:

All three habitat uncertainties are being addressed in a direct fashion through the suite of RME actions. They are highlighted above. Four other uncertainties are addressed more indirectly and primarily at the subbasin scale. They include Climate Change, Mainstem Hydro, Habitat, and Monitoring-Evaluation (adaptive management).

The Tucannon Programmatic project is a restoration “Umbrella” project focusing on improving Snake River spring Chinook habitat in the upper 30 miles of Tucannon River. The Snake River Salmon Recovery Board (SRSRB) is the lead and works with a variety of partners (State, Federal, and Tribal) to coordinate and support implementation of a variety of assessment, implementation, and monitoring and evaluation activities. A wide range of RME activities occur through the programmatic project and include (1) a variety of assessments (including validation of a 2005 EDT assessment using assessment and monitoring data developed in the last 10 years); (2) a suite of implementation monitoring efforts; (3) pre-post habitat restoration assessments that are fully coordinated with CHaMP and AEM programs; and (4) a WDFW Life Cycle Modeling project. It is stated by the SRSRB that information from the RME program is used “to gage the effectiveness of the restoration actions and inform adaptive management, the NOAA 5yr Stock Status Update and the BPA Expert Panel Process …” Overall, this appears to be a very well-organized and coordinated program of work.

Methods: The wide variety of RME activities are coordinated through the SRSB and appear to employ standard protocols and methods and statistical analyses. The levels of accuracy and precision are addressed in some areas. Discussions generally incorporate standard statistical methods. Since this is a programmatic project, many of the details of individual RME activities are not presented in the Annual Report and SRSRB is primarily a coordinator for RME activities.

Program Relevance and Project Results: RME activities include research, status and trend and project level monitoring. All of this work appears to be well-organized and coordinated and focused to improve the quality and management of restoration efforts. There is solid, ongoing linkage with CHaMP and AEM monitoring programs. Although a formal adaptive management program is not apparent, information and results appear to be used to improve design and implementation of the program. Quantitative habitat objectives are established for restoration on the upper Tucannon. They do not provide a time frame for completion but do describe a set of desired/expected riparian and aquatic habitat conditions. Independent assessments have concluded that the following habitat factors are the most significant limiting factors for spring Chinook salmon in the Tucannon River: elevated fine sediment, elevated water temperature, lack of channel complexity, lack of floodplain connectivity, and reduced streamflow.

Some preliminary findings from the RME work include documentation of increased low flows and generally reduced summer water temperatures presumably associated with restoration activities and a relatively high rate of pre-smolt Chinook mortality during the late fall and early winter at a higher rate than is observed in other watersheds.

For restoration effectiveness monitoring, the SRSRB adopted the CHaMP protocols for implementation monitoring in 2012. This was done so the habitat changes made through restoration could be directly compared to watershed-scale changes. This work is contracted with Eco Logical Research (ELR). They process, analyze, and develop the data and meta-data in www.champmonitoring.org. To improve effectiveness assessment, each project has quantitative habitat objectives assigned. This is one of the few projects reviewed that established such objectives to provide context for monitoring. An initial report was completed for the Programmatic project in 2014 describing the pretreatment conditions and the initial post treatment condition at Project Area (PA)-26 and PA-10, following implementation, but was not part of the Annual Report.

Coordination with US Army Corps of Engineers is also reported and is focused to better understand the issue of adult Chinook and steelhead (of known Tucannon origin) not entering the Tucannon and passing through Little Goose and Lower Granite hydro systems and the mortality associated with that behavior. It is noted that this work "… discovered that adult fish of known origin continue to pass the Tucannon River to above Lower Granite Dam with a very low rate of returning to the Tucannon (personal communication Glen Mendel WDFW). This phenomenon is apparently higher for steelhead (as high as 50%) than for Chinook which is closer to 25%."

Broad Applicability: In general, it appears that application of most results will be focused on the restoration of the Tucannon. Some information, on habitat and fish response to various combinations of restoration treatments, will likely be useful to inform work in other subbasins/streams with similar issues and species.

Time Required: This is an ongoing, long-term suite of RME activities being conducted as part of a programmatic project. Most activities do not have a stated completion date, and it seems likely that most work will not be completed in a 3-5 year time frame.

Lower Snake (Life History Studies)

201002800	Estimate Adult Steelhead Abundance in Small Streams Associated with Tucannon & Asotin Populations	Washington Department of Fish and Wildlife (WDFW)
199102900	Research, monitoring, and evaluation of emerging issues and measures to recover the Snake River fall Chinook salmon ESU	University of Idaho, US Fish and Wildlife Service (USFWS), US Geological Survey (USGS)
200203200	Snake River Fall Chinook Salmon Life History Investigations	Pacific Northwest National Laboratory, University of Washington, US Fish and Wildlife Service (USFWS), US Geological Survey (USGS)

201002800 - Estimate Adult Steelhead Abundance in Small Streams Associated with Tucannon & Asotin Populations

Links to: project and reports

Proponent: Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Columbia Plateau/Snake Lower

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

Comment:

The project contributes data that may be indirectly of use in relating hatchery production and survival of naturally produced fish in tributary habitats. Project data may also contribute to building predictive models for abundance with habitat data.

The project provides fish abundance data that could be used to develop models relating habitat to abundance. The data could also be used by others to relate survival of naturally produced fish in tributary habitats with hatchery production.

Methods: The project proponents try to use standard spawning ground counts and weir sampling, but trapping methods continue to change due to difficulty with excess variation in estimates of adult escapement.

Program Relevance and Project Results: The project is designed to contribute to status and trend analyses of ESA listed steelhead. The objective of conducting spawning surveys was not completed due to lack of access to a major portion of Almota Creek.

Broad Applicability: Lessons learned about the difficulties of trapping adult steelhead in small streams that can have high water events could be useful elsewhere if satisfactory trapping modification can be developed. Overall, the work in this project does not seem hypothesis driven.

Time Required: Several more years may be needed to make adjustments to methods and obtain enough reliable data to define status and trends. It is unlikely that definitive results can be obtained in 3-5 years.

199102900 - Research, monitoring, and evaluation of emerging issues and measures to recover the Snake River fall Chinook salmon ESU

Links to: project **and** reports

Proponent: University of Idaho, US Fish and Wildlife Service (USFWS), US Geological Survey (USGS)

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?

Indirect or Potential:

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?
- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- What are the factors that control wild salmon production and productivity?

Comment:

This is a collaborative project between the USFWS and the USGS. Objectives are to examine (1) habitat use by hatchery and natural Chinook spawners, (2) characteristics of natural-origin juveniles in mainstem riverine and reservoir habitats, and (3) predator responses in Snake River to an increase in abundance of juvenile fall Chinook. The project directly addresses carrying capacity of the mainstem river to support Chinook salmon (density dependence) and factors that control wild salmon production and productivity. In previous years, the project may have addressed a number of additional uncertainties.

Methods: The ISRP (2010) concluded that the project met scientific review criteria. Resulting data appear to have high levels of accuracy and precision. Methods include aerial redd surveys, seining juveniles and determining abundance by CPUE, PIT-tag detections of juveniles to determine migratory timing, mark-recapture abundance estimates of predators, and stomach content analyses of predators.

Program Relevance and Project Results: The project is highly relevant to the Fish and Wildlife Program and has tracked the increased abundance of juvenile and adult Fall Chinook in the upper Snake River since 1991. The project has used multiple lines of evidence (linear regression, Ricker and Beverton-Holt models) to identify density dependent responses to increasing abundances of adult and juvenile fall Chinook and report an increase in abundance and predation on juveniles by smallmouth bass. Evidence indicates density dependence among juveniles in the free-flowing Snake River and in the Lower Granite Reservoir. The proponents are in the process of developing a multi-stage life-cycle model to address action effectiveness and uncertainty research and to inform Fish Population, Hydrosystem, Harvest, Hatchery, and Predation and Invasive Species Management RM&E. According to ISRP (2010), the research questions have been refined and focused over the years and are addressing some of the most critical data gaps concerning this ESU.

Broad Applicability: The project results are primarily applicable to the Snake River, but methodology and overall findings of density dependence are relevant to other watersheds.

ISRP (2010) stated “The itemized list of management changes that have resulted from the findings of this study constitutes strong evidence of adaptive management. Their general approach could (and should) be applied to other programs in the Basin.”

Time Required: The project has been in place since 1991 and has an extensive monitoring and trends dataset, which allows ongoing tracking of quantitative biological objectives. Many manuscripts have been published. The project will continue into the foreseeable future.

200203200 - Snake River Fall Chinook Salmon Life History Investigations

Links to: project **and** reports

Proponent: Pacific Northwest National Laboratory, University of Washington, US Fish and Wildlife Service (USFWS), US Geological Survey (USGS)

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Mainstem Hydrosystem Flow and Passage Operations: What are the optimal temperature and water quality regimes for fish survival in tributary and mainstem reaches affected by dams, and are there options for hydrosystem operations that would enable these optimal water quality characteristics to be achieved? What would be the effects of such changes in operations and environment on fish, shoreline and riparian habitat, and wildlife?
- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?
- Non-native and invasive species: What is the current distribution and abundance of invasive and deliberately introduced nonnative species (e.g., the baseline condition), and how is this distribution related to existing habitat conditions (e.g., flow and temperature regimes, human development, restoration actions)?
- Population Structure and Diversity: What are the differential effects of flow augmentation, transportation, and summer spill on "ocean type vs. reservoir type" fall Chinook?

Comment:

This project addresses numerous critical uncertainties directly by developing and testing specific research hypotheses. The list of uncertainties shown above includes those addressed by the project since its inception. Estuary/Population Structure of fall Chinook - the project examined importance of timing of estuary entrance on fall chinook life history types. Habitat – the project examined the importance of natal, rearing and overwintering habitats on survival to adult of fall Chinook. Mainstem hydro operations/Nonnatives/Population structure – the project looked at the effects of flow, temperature, and gas supersaturation on fall Chinook life histories and on predation by smallmouth bass (SMB). Nonnative species – the project examined the distribution and abundance of smallmouth bass in Lower Granite Reservoir and above and has estimated predation rates on fall Chinook.

As its title implies, the project has looked at a wide range of RM&E questions about biotic and abiotic conditions that might affect life histories of fall Chinook in the Snake River. Topics include predation by smallmouth bass, the presence and abundance of non-native invertebrates, migratory behavior and habitat use of both juvenile and adult ocean- and reservoir-type fall Chinook and natural- vs hatchery-origin juveniles. Predation by nonnative smallmouth bass on juvenile Chinook in a section of the Lower

Granite Dam pool near Lewiston was quantified in 2013 and compared with findings in 1990s when Chinook abundance was much lower. Predation was much higher in 2013. Ideally, the investigators would have estimated percent mortality in the study reach (maybe they did not trust the Chinook abundance estimates which seemed low). Is there evidence of depensatory predation?

Methods: To accomplish a wide variety of tasks, the project uses an array of methods including otolith microchemistry to determine natal origin and habitat use of adults, mark and recapture and stomach content analysis of smallmouth bass, and laboratory experiments to determine the effects of temperature and total dissolved gas on predation by smallmouth bass on juvenile fall Chinook. All methods appear sound and most of their results have been published in peer-reviewed literature.

Program Relevance and Project Results: The research findings of this project are very relevant to the Fish and Wildlife Program, addressing numerous hypotheses relative to management of the Snake River fall Chinook populations. The project has examined the impact of hatchery releases on predation by smallmouth bass. It is not certain whether hatchery-origin fish are equally as productive or have the same fitness as natural-origin fish. Through the use of otolith microchemistry, this project is quantifying the origin and rearing location of unmarked returning adults and thereby identifying areas that are productive in terms of abundance and diversity of life histories. In 2012, based on otolith analyses they found no significant differences between subyearlings and yearlings in terms of size at estuary entry and exit, and estuary growth. On average, subyearlings and yearlings spent about 27 and 30 days in the estuary, respectively, and grew about 38 and 41 mm during that time. Most adults were estimated to have originated, reared, and overwintered in the lower Snake River, which was consistent with results from the analysis of adults collected in previous years (2006-2008). These are important findings that can inform habitat restoration efforts and answer the question: where do Chinook rear?

Broad Applicability: The methods, experimental approaches and data developed by this project have broad applicability to other watersheds and other species. The management and conduct of this project could be used as a template for projects in other areas of the Columbia Basin as they have identified questions about fall Chinook in the Snake River, developed hypotheses, and conducted research adaptively to greatly increase our understanding of these populations.

Time Required: The project has been in place since 2002 and each research element has appropriate time frames. For example, the examination of smallmouth bass predation began in 2012 and is slated for completion in 2017.

Grande Ronde

[200900400]()	Monitoring Recovery Trends in Key Spring Chinook Habitat Variables and Validation of Population Viability Indicators	Columbia River Inter-Tribal Fish Commission (CRITFC)
[199202601]()	Grande Ronde Model Watershed	Grande Ronde Model Watershed Foundation

Summary

There is a very large contrast in the quality of these two programs.

The CRITFC project (2009-004-00) could serve as a model for similar efforts in the Columbia River Basin and elsewhere. It is well coordinated and reflects a high level of integrated research and analyses. Program relevance lies in two critical uncertainties for fisheries managers in the Columbia River Basin: whether habitat restoration actions will yield a net improvement in basinwide habitat quality, and whether expected improvements in fish production can be brought about by improvements in the quality and quantity of salmon habitat. Significant progress has been made over the last four years in collection of high quality stream habitat and biotic data as well as development of analytical tools needed to quantify status and trends in habitat conditions and fish populations and to evaluate effectiveness of aggregate restoration activities. The annual report offers a rare glimpse of what can be accomplished through thoughtful monitoring, adopting a landscape perspective, and conducting integrated analyses.

In contrast, the Grande Ronde Model Watershed project (1992-026-01) annual report, reviewed for this report, raises significant questions about the efficacy of this project. The administrative aspects may provide some insights for other projects; otherwise, actions are not described that have broad applicability.

200900400 - Monitoring Recovery Trends in Key Spring Chinook Habitat Variables and Validation of Population Viability Indicators

Links to: project **and** reports

Proponent: Columbia River Inter-Tribal Fish Commission (CRITFC)

Province/subbasin: Blue Mountain/Grande Ronde

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

Comment:

Summary: Program relevance lies in two critical uncertainties for fisheries managers in the Columbia River Basin: whether habitat restoration actions will yield a net improvement in basinwide habitat quality, and whether expected improvements in fish production can be brought about by improvements in the quality and quantity of salmon habitat. Significant progress has been made over the last four years in collection of high quality stream habitat and biotic data as well as development of analytical tools needed to quantify status and trends in habitat conditions and fish populations and to evaluate effectiveness of aggregate restoration activities. The annual report offers a rare glimpse of what can be accomplished through thoughtful monitoring, adopting a landscape perspective, and conducting integrated analyses. This project could serve as a model for similar efforts in the Columbia River Basin and elsewhere. The project is well coordinated, and a high level of integrated research and analyses are apparent.

General Comment: CRITFC conducts a fish habitat monitoring program in the Upper Grande Ronde River and Catherine Creek basins to evaluate the effectiveness of aggregate restoration actions in improving freshwater habitat conditions and viability of salmonids listed under the Endangered Species Act. Primary objectives are to: (1) Assess current status and trends in fish habitat characteristics considered to be key limiting factors (particularly water temperature, pool habitats, streamflow, and fine sediment) to viability of spring Chinook salmon populations; (2) Evaluate effectiveness of aggregate stream restoration actions aimed at improving key limiting habitat factors; and (3) Develop a life cycle model to link biotic responses of spring Chinook populations to projected changes in stream habitat conditions.

Methods: The central component is a spring Chinook life cycle model, which provides the means to integrate habitat monitoring efforts with recovery planning. Standard methods are used for estimating juvenile Chinook densities, abundance and composition of macroinvertebrates, and characterizing stream habitat (CHaMP) and landscape conditions. Rotational monitoring is employed, and effective data management is a key attribute of the program.

Program Relevance and Project Results: Progress has been made for the various components of the life history model**.** The model is comprised of several interacting subcomponents that are built independently, each of which provides critical information about the interaction between landscape characteristics, instream habitat conditions, and fish response. Some findings and results include:

Juvenile salmonid abundance: Juvenile Spring Chinook rearing densities decreased over the 2011-2014 period in the upper Grande River and Catherine Creek. This pattern coincided with increasing water temperatures over the same period, but the exact reason for decline is yet to be determined. Juvenile Spring Chinook rearing densities were generally lower in the Minam River, but constant over time.

Benthic macroinvertebrates: BMI indices were strongly linked to watershed characteristics and are sensitive to fluctuations in conditions rendering them good indicators of environmental change.

Stream habitat conditions: Initial summaries of seven habitat metrics are given. The results from the valley setting analysis hold promise for using this classification system to extrapolate habitat metrics to un-sampled sections of streams.

Stream temperature analyses: They compared predicted stream temperatures using the NorWeST temperature model in the upper Grande Ronde watershed with measured water temperature and found that the NorWeST temperature models do not perform as well when scaled down to the Grande Ronde watershed as they do on a regional and statewide scale.

Broad Applicability: There is good potential for using the life cycle model which is comprised of several interacting subcomponents that are built independently, each of which provides critical information about the interaction between landscape characteristics, instream habitat conditions, and fish response. Although the specific relationships are likely to vary by location, this general approach provides a good template for use in other areas.

Time Required: An additional 5-8 years (1-2 Chinook salmon generations).

199202601 - Grande Ronde Model Watershed

Links to: project **and** reports

Proponent: Grande Ronde Model Watershed Foundation

Province/subbasin: Blue Mountain/Grande Ronde

2006 Research Plan uncertainties addressed: None

Comment:

Summary: While the potential relevance of the program is strong, the annual report by the GRMW does not provide the necessary details to evaluate progress. In general, there are no data analyses, monitoring data are not analyzed (e.g., discharge data are listed but not analyzed), it is not clear how data or results are used to improve management actions or restore fish populations. The progress report documents do not demonstrate that this is an integrated and productive program.

General Comment: This is a multifaceted project with several recent annual reports for individual work elements. The Grand Ronde Model Watershed Project needs to summarize individual work elements and produce one overarching annual report. It is nearly impossible to understand what has, or has not, been accomplished from the separate reports. Further, a comprehensive data analysis is needed that examines the overall success or failure of the project.

Reviewers examined the following:

Sheep Creek Large Woody Debris and Planting Project; 5/13 - 4/15	5/2013 - 4/2015
Ladd Creek - Highway 203 Culvert Replacement	7/2013 - 10/2014
Grande Ronde Subbasin Gauging Station Operations	10/2013 - 9/2014
Battle Creek Restoration Project	5/2012 - 6/2014
Grande Ronde Model Watershed Foundation Administration; 5/13 - 4/14	5/2013 - 4/2014
Meadow Creek Large Woody Debris Phase I Project; 5/12 - 2/14	5/2012 - 2/2014

Methods: The proponents use a variety of standard methods to add wood to streams, modify culverts, measure discharge, and construct an irrigation system on a golf course.

Program Relevance and Project Results: While the potential relevance of the program might be strong, the annual report by the GRMW does not provide the necessary details to evaluate progress. In general, there are no data analyses, monitoring data are not analyzed (e.g., discharge data are listed but not analyzed), and it is not clear how data or results are used to improve management actions or restore fish populations.

Broad Applicability: The administrative aspects may provide some insights for other projects; otherwise, no actions are described that have broad applicability.

Time Required: The quality of the reports evaluated raise questions about the efficacy of this project. Reporting needs to be improved to better inform fish restoration in the region. The Council and the ISRP will review this and other "umbrella" projects' accomplishments in 2017.

Asotin

200205300 - Asotin Creek Salmon Population Assessment

Links to: project **and** reports

Proponent: Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Blue Mountain/Asotin

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?

Comment:

The project produces estimates of abundance, productivity, survival rates, and temporal and spatial distributions that could contribute to examination of the relationship between basinwide hatchery production and survival of naturally produced fish in freshwater habitats. In addition, because of the high abundance of the Asotin Creek steelhead population, the data contributed by this project could serve as a supplementation reference for investigations of fish propagation management rules.

Final results are pending in this, the tenth year, of status and trend monitoring. Assuming the proponents are able to gain access to data from researchers working on the mainstem Columbia and Snake in the near future, the final results should be available in the near future.

The project is collecting data that can be used to inform the uncertainties concerning fish propagation.

Methods: This is a status and trend M&E project for steelhead on Asotin Creek and associated Snake River tributaries (Alpowa, Almota, Couse and Tenmile Creeks), in which the proponents are estimating abundance, productivity, survival rates, and temporal and spatial distributions. This report reflects the tenth season of monitoring. Methods include the use of floating, resistance board weirs and traditional picket-style weirs to trap and measure adult fish and a rotary screw trap to estimate populations of juvenile steelhead (and chinook). Methods for estimating abundance were updated to incorporate uncertainties, and the proponents continue to update their methods to improve estimates. These updated methods have not been applied to historical data yet, but the proponents state that they intend to.

The report is comprehensive and well written.

Program Relevance and Project Results: This project focuses on status and trend M&E. Final results are pending.

Broad Applicability: The results may be useful in that the proponents identified this area as a potential reference for management of other populations. As the proponents note, "The entire Asotin Creek steelhead population may be near or above the Viable Salmonid Population (VSP) abundance thresholds; making Asotin Creek a valuable supplementation reference stream." The results also may contribute to understanding the timing and distribution of wild versus hatchery fish.

The authors also identify important needs related to improving monitoring and hatchery programs (page 46).

The report includes a section on dissemination of information, but it appears that the only dissemination of information was the annual report to BPA.

Time Required: The work is apparently hampered by delayed access to data from researchers working on the mainstem Columbia and Snake.

Clearwater

200206800	Evaluate Stream Habitat- Nez Perce Tribe Watershed Monitoring and Evaluation (M&E) Plan	Nez Perce Tribe
200207000	Lapwai Creek Anadromous Habitat	Nez Perce Soil and Water Conservation District (SWCD)
200206100	Potlatch River Watershed Restoration	Latah Soil and Water Conservation District (SWCD)

Summary

Information on RME activities is either not provided or of limited quantity and quality for all of the reports for the Clearwater subbasin. It is not clear why this may have occurred. The net result is a limited description of ongoing RME work, findings, and relevance to ongoing watershed and habitat restoration work.

200206800 - Evaluate Stream Habitat- Nez Perce Tribe Watershed Monitoring and Evaluation (M&E) Plan

Links to: project and reports

Proponent: Nez Perce Tribe

Province/subbasin: Mountain Snake/Clearwater

See the comments for CHaMP and ISEMP. This project is coordinated and implemented under those projects.

200207000 - Lapwai Creek Anadromous Habitat

Links to: project and reports

Proponent: Nez Perce Soil and Water Conservation District (SWCD)

Province/subbasin: Mountain Snake/Clearwater

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Climate Change: What long-term changes are predicted in the Columbia River Basin and the northeast Pacific Ocean, how will they affect the fish and wildlife in the region, and what actions

can ameliorate increased water temperatures, decreased summer river flows, and other ecosystem changes?

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?

Comment:

A comprehensive reporting of RME activities for 2014 is not provided. Other than for water temperature (9 sites), it is difficult to understand the role of the full RME program as related to ongoing habitat protection and restoration activities. Additionally, it is not possible to relate contributions of RME activities to direct resolution of any specific critical uncertainties.

There is limited RME information provided in the FY 13 and 14 reports. There is a temperature Monitoring report provided for 5/2014 to 4/2015. There is also a PPT presentation on RME which provides a brief cross section on ongoing activities and displays ongoing monitoring for a number of water quality and stream condition parameters (turbidity, nitrates, pebble counts, bank erosion, streamflow, soil quality and stream assessment), in addition to water temperature. For other than water temperature, results of this more comprehensive, water quality monitoring effort are not discussed.

Methods: The only monitoring activity with a description of methods and protocols was for Temperature Monitoring (summer stream temperatures). Monitoring methods are described and water temperature objectives are established. There are 39 sites in the watershed using continuous data, recording devices to track stream water temperatures. Monitoring frequency is outlined in the Nez Perce Soil and Water Conservation District's (NPSWCD) Stream Temperature Monitoring Plan. As noted in the report regarding this monitoring, "objective is to reduce in-stream temperatures to the benchmark conditions of zero days of water temperature exceeding 16C (NOAA, 1996) … stream temperature data are collected for the purpose of implementation and compliance (I & C) monitoring and trend monitoring." Annual temperature data is uploaded to the StreamNet website.

There is limited discussion of methods/protocols and limited discussion regarding accuracy and precision of measurements or analysis of results.

Program Relevance and Project Results: There is some discussion of Water Temperature monitoring and its linkage to program objectives, current trends and locations for potential restoration work. Other water quality parameters are mentioned, but there is little discussion regarding their connection to physical or biological project objectives or their application in adaptive management for the project. It appears that there is a project website where a variety of information, including RME, is said to be provided. A review of the site did not provide any additional, comprehensive RME reporting.

Broad Applicability: Based on limited information, it appears that the use of RME findings are limited to the general project area.

Time Required: There is no discussion of time frames for RME activities to yield necessary results for supporting project activities.

200206100 - Potlatch River Watershed Restoration

Links to: project **and** reports

Proponent: Latah Soil and Water Conservation District (SWCD)

Province/subbasin: Mountain Snake/Clearwater

2006 Research Plan uncertainties addressed: None

Comment:

RME activities for the project appear very limited, and there is a cursory reporting of RME activities (photo point monitoring and stream flow measurement). No critical uncertainties appear to be addressed by the program either directly or indirectly.

The only mention of RME activities in the FY 2014 report is for a contract item #187 "Continue Watershed Monitoring." It involves Latah SWCD maintaining a monitoring program for the Potlatch River system. This involves photo point monitoring and stream gauging. Stream gaging was reportedly undertaken with Latah SWCD field staff and through contract with the USGS.

Methods: There is no discussion of methods for either of the mentioned RME activities.

Program Relevance and Project Results: There is no analysis or presentation of results for monitoring data. There is no discussion of the potential relevance of these RME activities to ongoing restoration activities or contributions in identifying High Level Indicator accomplishments. It is noted that Latah SWCD periodically revises the Watershed Action Plan which apparently guides watershed- scale activities. There is no formal adaptive management process that is apparent to supports this.

Broad Applicability: RME work appears to have limited application to this river system.

Time Required: There is no discussion on planned time frames for RME activities or their completion.

Salmon River

199902000	Analyze Persistence and Dynamics in Chinook Redds	US Forest Service (USFS)
199405000	Salmon River Habitat Enhancement	Shoshone-Bannock Tribes
200205900	Yankee Fork Salmon River Restoration	Shoshone-Bannock Tribes
200890300	ESA Habitat Restoration	Shoshone-Bannock Tribes

199902000 - Analyze Persistence and Dynamics in Chinook Redds

Links to: project **and** reports

Proponent: US Forest Service (USFS)

2006 Research Plan uncertainties addressed:

Direct:

- Population Structure and Diversity: What approaches to population recovery and habitat restoration are most effective in regaining meta-population structure and diversity that will increase viability of fish and wildlife in the Columbia River Basin?

Indirect or Potential:

- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Population Structure and Diversity: What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

Comment:

This project directly addresses the uncertainty about population structure and diversity, including uncertainties about the importance of spatial structure, population connectivity and synchrony, metapopulations, and landscapes to the persistence of wild Chinook salmon in a relatively pristine wilderness area by describing spatial patterns in extinction and colonization dynamics of wild spring-summer Chinook salmon populations in the Middle Fork of the Salmon River (MFSR). At least three useful journal publications have stemmed from this effort. These publications examine the dynamic spatial structure of Chinook in response to changes in abundance over time, and they highlight the importance of connectivity. The investigators link their research in this wilderness area to habitat restoration in more degraded habitats in the Columbia Basin.

Methods: Methods for counting and geo-referencing redds (helicopter survey) seem reasonable, but little analysis of data is presented in the recent annual report.

Program Relevance and Project Results:

Status and Trend Monitoring: The project has two specific objectives: (1) to monitor wild Chinook salmon distribution, abundance, and trend by mapping the annual distribution of Chinook salmon redds across the entire MFSR basin; and (2) to assess spatial and temporal patterns in extinction and colonization dynamics of wild Chinook salmon.

Results from the study (since 1995) include a time series of annually geo-referenced salmon redds and archived tissue samples (fin rays, genetic samples and otoliths) from more than 800 km of spawning habitat. The proponents state that these data are being used by other studies to address key conservation issues for Chinook salmon including assessment of temporal changes in population synchrony; examination of linkages between fine-scale genetic structure, demographic parameters, and environmental characteristics; evaluation of methods for monitoring salmon populations; determination of dispersal ranges and environmental constraints using spatial autocorrelation analysis; validation of hydrologic models for predicting basinwide distributions of spawning substrates; assessment of environmental covariates that affect habitat occupancy; and validation of redd counting methodologies.

The ISRP (2010) advised that the relevance of this project “hinges on how valuable the long-term data set for Chinook salmon redds in MFSR is, and whether it should be continued. The funding request is strictly for helicopter survey time. Despite the considerable text in the proposal, there is no research component for which funding is requested. It is essentially monitoring, with potential for significant research applications.” The ISRP (2010) also commented that the proposal did not explain the “tremendous analytical potential” of the [then] 15-year dataset, or provide testable hypotheses to show the relevance of patch size/isolation/landscape theory to Chinook. However, we note here that the investigation has led to at least three useful journal publications (i.e., applied and theoretical applications) on the spatial structure and connectivity of spawning Chinook in relation to changes in population abundance.

Broad Applicability: The MFSR is a unique but valuable study area because it lies mostly within a designated wilderness, has not been heavily altered by anthropogenic disturbance, has little hatchery or non-native fish influence, and is used by naturally produced fish that spawn in multiple locations throughout the drainage system. Theory about the importance of spatial structure developed and tested in the MFSR would probably be applicable to other areas.

Time Required: The ISRP (2010) concluded that “it is not apparent what several additional years of data would contribute to assessing Chinook salmon persistence at the population, MPG, and ESU scales. Nothing in the proposal is compelling. The ISRP could be more supportive if valuable and relevant testable hypotheses were provided” and that “based on the current proposal the ISRP believes it might be time to think of it as being successfully completed.” However, the long-term dataset is unique in that it monitors the status of one of the few Chinook populations in a relatively pristine habitat within the Columbia Basin. For this reason, continued monitoring is valuable.

199405000 - Salmon River Habitat Enhancement

Links to: project **and** reports

Proponent: Shoshone-Bannock Tribes

Province/subbasin: Mountain Snake/Salmon

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Indirect or Potential:

- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

Comment:

This project looks at what habitat characteristics may be associated with freshwater mussels (rather than fish). Project 2002-037-00 also deals with freshwater mussels. The two groups should collaborate.

Methods: The project does habitat monitoring in Yankee Fork Salmon River using CHaMP on 45 sites with rotating panel design (25 sites/year) starting in 2013.

They also conducted a survey to look for freshwater mussels and measured associated habitat variables.

Program Relevance and Project Results: The habitat monitoring is relevant to any project looking at how habitat responds to restoration actions. No data were presented in the report.

Project staff completed inventory for Bear Valley, Yankee Fork, and Panther Creek for freshwater mussels. Presence/absence data were presented by stream section. No freshwater mussels were detected in Yankee Fork or Panther Creek despite historical evidence of presence. (Many sections have none because salmon are extirpated, and salmon are believed to be intermediate hosts for the mussels.)

Broad Applicability: The habitat response to restoration should be compared with other projects. Freshwater mussel occurrence may be very site specific, and the habitat variables associated with freshwater presences are difficult to determine.

Time Required: The goal of the project is to monitor and implement habitat restoration actions in Yankee Fork and collaborate with the Yankee Fork Restoration Project. It will continue into the foreseeable future.

200205900 - Yankee Fork Salmon River Restoration

Links to: project **and** reports

Proponent: Shoshone-Bannock Tribes

Province/subbasin: Mountain Snake/Salmon

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

Comment:

To date, no uncertainties have been addressed, but this project has the (very) long term possibility of addressing the impact of habitat restoration.

Methods: The goal of the Yankee Fork Dredge Tailings Restoration Project is to restore natural river channel characteristics, floodplain function, hydraulic and sediment regimes, and aquatic habitat within the dredged reach of the Yankee Fork, initially by redistributing dredge tailings piles from the floodplain.

Program Relevance and Project Results: Basic water quality monitoring data during 2011 to 2013 were described in one recent report. Another annual report described wetland restoration activities. This effort simply described recent restoration efforts in this highly degraded watershed. To date, no uncertainties were directly addressed.

Some advice on contracting is provided.

Broad Applicability: This project is very site-specific because of the highly degraded current condition of the site.

Time Required: 10+ years will be needed before benefits will be seen. There is no mention of monitoring to see if fish respond to activities.

200890300 - ESA Habitat Restoration

Links to: project **and** reports

Proponent: Shoshone-Bannock Tribes

Province/subbasin: Mountain Snake/Salmon

2006 Research Plan uncertainties addressed:

Indirect of Potential:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Comment:

This project performs habitat restoration; monitoring (done elsewhere) could determine if the restoration activities lead to a positive fish response.

Methods: The project installed fencing; removed/replaced some culverts; and restored meander in a stream.

Program Relevance and Project Results: Habitat changes to be monitored using the CHaMP protocol (described in another project). This project could change the density of rearing fish and so if monitored could provide information on density dependence.

Broad Applicability: The results from this project are very site specific.

Time Required: Many projects were delayed due to manpower bottlenecks and unexpected ground conditions. Many years of effort will be needed to continue the restoration activities.

Columbia Cascade (Wenatchee, Entiat, Methow, Okanogan)

201007500	Upper Columbia Project-Scale Action Effectiveness Monitoring	Upper Columbia Salmon Recovery Board
201003400	Upper Columbia Spring Chinook and Steelhead Juvenile and Adult Abundance, Productivity and Spatial Structure Monitoring	Washington Department of Fish and Wildlife (WDFW)
200302200	Okanogan Basin Monitoring & Evaluation Program (OBMEP)	Colville Confederated Tribes
200000100	Omak Creek Anadromous Fish Habitat and Passage	Colville Confederated Tribes
200722400	Okanogan Subbasin Habitat Implementation Program (OSHIP)	Colville Confederated Tribes

201007500 - Upper Columbia Project-Scale Action Effectiveness Monitoring

Links to: project and reports

Proponent: Upper Columbia Salmon Recovery Board

Province/subbasin: Columbia Cascade/Entiat, Columbia Cascade/Methow, Columbia Cascade/Okanogan, Columbia Cascade/Wenatchee

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Monitoring and Evaluation (adaptive management): Can a scientifically credible trend monitoring procedure based on remote sensing, photography, and data layers in a GIS format be developed?
- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

Comment:

Summary: The annual report calls attention to the efforts the monitoring project makes to integrate with other monitoring activities in the region including the Columbia Basin Habitat Monitoring Program

(CHaMP), Action Effectiveness Monitoring (AEM), and the Washington Salmon Recovery Funding Board (SRFB) Reach-Scale Effectiveness Monitoring Program and partnerships with the Yakama Nation, the Colville Tribe, Chelan County, USFWS, Trout Unlimited, and private landowners. The relevance relates to evaluating the effectiveness of restoration actions on fish abundance and productivity, as well as habitat quality and connectivity. An additional 8+ years are needed to provide statistically valid analyses of restoration actions.

Methods: The projects in the UCSRB Program are in two general categories: Floodplain Enhancement and Instream Habitat. Accepted protocols are used for each and are listed in the most recent annual report, although detail is lacking. There is a brief, but clear, description of statistical methods used. The methods are appropriate, but the authors of the report may want to investigate some of the recent criticism of BACI sample designs and consider other designs in the future.

Program Relevance and Project Results: The goal of the Upper Columbia Salmon Recovery Board's (UCSRB) Project-Scale Effectiveness Monitoring Program is to measure the habitat and fish response to restoration projects in the Upper Columbia Basin, over the long term, using proven protocols. The relevance relates to evaluating the effectiveness of restoration actions on fish abundance and productivity, as well as habitat quality and connectivity. A comprehensive monitoring program is in place, but it has been conducted only since 2011; therefore, in-depth trend and spatial analyses are not available.

Broad Applicability: The overall programmatic structure appears to be applicable to similar situations where restoration effectiveness for improving fish populations is the primary concern.

Time Required: An additional 8+ years are needed to provide statistically valid analyses of restoration actions.

201003400 - Upper Columbia Spring Chinook and Steelhead Juvenile and Adult Abundance, Productivity and Spatial Structure Monitoring

Links to: project **and** reports

Proponent: Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Columbia Cascade/Methow

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?

- Population Structure and Diversity: How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?

Comment:

Steelhead abundance in the upper Columbia River Basin were estimated using fish PIT tagged at Priest Rapids Dam and recaptured at various locations in each of the four independent populations. Tasks associated with fish habitat were initiated late in 2014; the data are not yet ready for analysis. The objectives of the fish RM&E project are to (1) estimate the number and proportion of natural and hatchery steelhead in each primary population and the number and proportion of those fish that reach tributary spawning grounds; (2) estimate the precision of redd counts for both steelhead and spring Chinook Salmon; and, (3) conduct a steelhead radio telemetry study to independently validate escapement estimates generated from the PIT tag based model, and estimate steelhead population characteristics. The objectives of the tributary habitat RM&E are to collect (1) spatially and temporally explicit survival and movement data; (2) complete life-cycle modeling to evaluate bottlenecks and population response to various actions; and (3) conduct watershed analysis to quantify historical and current habitat conditions, and prioritize actions based on life-cycle model output.

Methods: Standard methods are used for most fish-related (PIT tags, redd counts, and so forth) and habitat activities. A unique approach is used to estimate the precision of redd counts by visual observation. Links to individual protocols are provided for both fish and habitat assessments.

Program Relevance and Project Results: The overall program addresses two important management questions for the Upper Columbia: (1) What are the status and trend of adult abundance of natural and hatchery origin fish populations? (2) What are the tributary habitat limiting factors (ecological impairments) or threats preventing the achievement of desired tributary habitat performance objectives? Only the initial monitoring has been conducted; it will be several years before trends and in-depth analyses are available. Will it be possible to use historical estimates of abundance in these analyses?

Broad Applicability: The overall approach appears logical; the structure could be applied elsewhere.

Time Required: An additional decade will be needed to reveal spatial and temporal trends.

200302200 - Okanogan Basin Monitoring & Evaluation Program (OBMEP)

Links to: project and reports

Proponent: Colville Confederated Tribes

Province/subbasin: Columbia Cascade/Okanogan

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Population Structure and Diversity: What approaches to population recovery and habitat restoration are most effective in regaining meta-population structure and diversity that will increase viability of fish and wildlife in the Columbia River Basin?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Habitat: How do environmental factors such as water quality affect the survival, productivity, distribution, and abundance of native fish populations?

Comment:

Summary: The Program is accomplishing its stated goals to understand the abundance, productivity, and spatial/temporal distribution of anadromous fishes (adults and juveniles) in the Okanogan subbasin. The monitoring of juveniles was not very effective before 2014, but adjustments have been made to improve sampling effectiveness. In general, adult and juvenile steelhead numbers are increasing. The report does a good job of summarizing status and trend conclusions, and especially noting limitations in data and methods. The candor with which uncertainties are identified is appreciated. The lessons learned and recommendations for the future are expansive and commendable. However, it is disconcerting that a project that has been active for so long should have identified so many data gaps and uncertainties. It may take quite a long time to resolve so many unknowns including egg-to-fry/parr survival in mainstem habitats, predator-prey relationships affecting anadromous salmonids in the Okanogan subbasin, and reasons for the absence of juvenile salmonids in summer snorkel surveys.

Methods: Standard methods are used, depending on specific actions. Data management and coordination is especially impressive and appears to be well advanced relative to other Basin projects. Results are actively used to inform management actions (adaptive management). The integration of monitoring, modeling, and management presented in this report is good, but more detail on the uncertainties of the modeling would improve the annual report. For example, it is unclear from the description if EDT is statistically based and, as well, how uncertainty is handled with the model.

Program Relevance and Project Results: See the comments in the summary above. In addition, adult and juvenile steelhead appear to be increasing, possibly because of a relationship between flow and abundance. However, additional factors could be influencing this relationship as noted by other parts of the report.

By comparing snorkel surveys with mark-recapture results, this project addresses the 2006 Research Plan uncertainty: "Habitat: Are the current procedures being used to identify limiting habitat factors accurate?"

Section 3.4.3 mentions concerns about nitrate concentrations, but it is unclear if nitrates will be measured in the future to address this uncertainty/concern.

Broad Applicability: This is a well-coordinated and comprehensive monitoring and restoration program, one which could act as a model for others.

Time Required: While the program has made great strides in a decade, another 5-10 years of activities will be needed for the study, and at least that much time before the delisting of summer steelhead is accomplished (1,000 natural origin fish) and a diversity of natural populations is sustainable.

200000100 - Omak Creek Anadromous Fish Habitat and Passage

Links to: project **and** reports

Proponent: Colville Confederated Tribes

Province/subbasin: Columbia Cascade/Okanogan

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?

Comment:

The annual report addresses actions associated with anadromous fish habitat and fish passage on Omak Creek, part of the Colville Indian Reservation.

Methods: Standard methods were used to tag fish moving to upstream reaches. Debris and barrier removal were conducted by an engineering company. Riparian fencing was examined by Tribal staff, as was weed control and riparian planting.

Program Relevance and Project Results: The program has relevance for the restoration of summer steelhead in Omak Creek. Fish passage and sedimentation were identified as major limiting factors. Passage improvements have been made at the Mission Falls reach of Omak Creek. More work in this portion of the watershed is taking place to continue to improve passage conditions for summer steelhead. Sedimentation was also identified as a major limiting factor. A number of actions are occurring in the Omak watershed to reduce sedimentation. They include, livestock management (timing of grazing and implementation of grazing strategies), reconnection to the flood plain along the Disautel Reach, obliteration of roads, incorporation of drainage techniques, replacing or improving stream crossings, installing stream structures, re-contouring of vertical stream banks and roads, and installing livestock fences. It is unclear what types of monitoring are occurring to evaluate the effectiveness of these measures; no data analyses are included in the report. It appears that work is being done, but in future reports, it would be helpful to indicate what monitoring protocols are being used and to provide data produced from those efforts.

Broad Applicability: Some of the habitat rehabilitation measures being employed may be useful in other parts of the Basin. However, their effectiveness in the Omak will need to be quantitatively evaluated before that can occur.

Time Required: Given the current conditions in Omak Creek it is clear that additional years (>5) of habitat restoration and evaluation will need to occur.

200722400 - Okanogan Subbasin Habitat Implementation Program (OSHIP)

Links to: project **and** reports

Proponent: Colville Confederated Tribes

Province/subbasin: Columbia Cascade/Okanogan

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?

Comment:

Summary: Important efforts are directed at restoring access and habitat for the spawning and rearing of anadromous salmonids, as well as securing water rights and replacing non-compliant fish screens. Basic data are collected on barriers and stream conditions (e.g., temperature, sedimentation); however, there does not appear to be any multiyear monitoring of salmonid populations to determine if the restoration actions are effective. Adaptive management is not employed for the majority of projects. If these issues are addressed, an additional 5-8 years of restoration actions and direct monitoring of fish abundance and productivity will be required to determine if the overall restoration is successful. Fish and habitat data related to this project are collected and evaluated through the Okanogan Basin Monitoring and Evaluation Program (OBMEP).

General Comment: OSHIP is a long term (20+ years) project. The Okanogan River, Similkameen River and associated tributaries have several factors limiting salmonid production and rearing: in-stream barriers, water quantity, water quality, water temperature, channel flow, habitat complexity, flood plain activation, cold water rearing habitat, and streambed sedimentation and substrate size. Much of the recent project (2008 – 2013) was spent addressing barriers to fish migration through replacing culverts and pursuing additional in-stream water flow. The project adapts as knowledge is gained about limiting factors affecting the specific life stages of salmonids throughout the mainstem and tributary habitats in the Okanogan River Basin.

Methods: Standard engineering approaches to culvert and barrier removals, land purchases, riparian fencing, and floodplain connections; other acceptable approaches are employed for related activities.

Program Relevance and Project Results: Important efforts are directed at restoring access and habitat for the spawning and rearing of anadromous salmonids, as well as securing water rights and replacing non-compliant fish screens. Basic data are collected on barriers and stream conditions (e.g., temperature, sedimentation); however, there does not appear to be any multiyear monitoring of salmonid populations to determine if the restoration actions are effective.

Broad Applicability: The methods and actions used are already widely implemented in the Basin and elsewhere.

Time Required: An additional 5-8 years of restoration actions and direct monitoring of fish abundance and productivity will be required to determine if the overall restoration is successful.

Resident Fish

Summary

1. How can we more effectively assess which resident fish substitutions are the most appropriate choices in particular instances?

A major theme underlying many resident fish projects under the Fish and Wildlife Program is the effort to compensate for the loss of anadromous salmonids by enhancement of substitute coldwater resident species, both natives and non-natives, including kokanee, brook trout, redband trout, and rainbow trout. In other cases, coolwater and warmwater species (walleye, basses) are also included as substitutes for anadromous fish losses. Typically, brook char (trout), rainbow and cutthroat trout, and kokanee salmon are substituted for Chinook salmon and steelhead, and often the fisheries are created and maintained using fish stocked from hatcheries. The fish rearing, stocking, and harvest strategies usually are either “put-grow-and-take” or “put-and-take.” Such resident fish substitutions and their impacts on native species were noted in 2006 in the Columbia River Basin Research Plan (p. 21) and have been the subject of a past (2008) report by the ISAB on non-native species impacts on native salmonids in the Columbia River basin (ISAB 2008-4). Numerous uncertainties surrounding these substitutions (and potential effects of non-natives on natives in general) were identified in the report, including predation, competition for food and habitat, food web alterations, interbreeding (e.g., introgression) and disease transmission and parasites. Native fish, invertebrates, and plants have all been affected by non-natives, some intentionally introduced, some not. A major programmatic uncertainty surrounds how to most effectively and realistically implement fish substitutions (i.e., intentional introductions and enhancements) and at the same time how to assess the potential impacts of non-natives on the native fauna. In many of these situations, developing harvestable populations of these species substitutes (e.g., kokanee) has been hindered by the presence of altered habitats, where the modified habitat is more appropriate for other species, often non-natives. Managers have at times persisted in the specific species management objectives, with very limited success, for their favored species, some of which are poorly adapted to new conditions and subject to negative effects of predation and competition.

More explicit criteria for species selection and progress are needed. The uncertainties regarding fish substitutions are detailed in ISAB 2008-4, in which it is recommended that a 15-step risk assessment be conducted when implementing fish substitution projects. In addition, other actions need to be taken in several areas including exploratory surveillance and monitoring for non-native invasions, more liberal fishing regulations on non-native predators on salmonids, direct prevention/removal of problem species, habitat restoration to favor native species, and more focused planning, education, and research. For projects showing little progress, additional justification for particular substitutions may be needed.

2. What are the potential effects of proposed habitat improvement actions for restoring native species in relation to their potential for spreading non-native species?

While the deliberate, authorized introduction of new non-native fishes is likely to be very closely regulated in the future, unauthorized releases continue to occur. In addition, little attention has been given in the resident fish proposals to the expansion of non-native aquatic invertebrates as well as aquatic and riparian plants, with the exception of the aquatic diatom *Didymosphenia geminata* and Eurasian water milfoil *Myriophyllum spicatum*, which displace other aquatic life. The spread of unwanted non-native species constitutes an under-recognized threat to the effectiveness of habitat restoration projects by re-directing the benefits of habitat improvements to non-target species. Two categories of habitat actions particularly susceptible to facilitating species invasions are migration barrier removals and riparian revegetation efforts. In either case, unwanted plants and animals are provided with unrestricted passage to previously inaccessible habitat or are inadvertently introduced with planting stock (e.g., invasions by non-native brook trout into native cutthroat trout habitat when barriers are removed; Fausch et al. [2009; Conservation Biology 23:859-870]). More explicit consideration of the tradeoffs is needed. A decision support analysis tool is available via Peterson et al. (2008; Canadian Journal of Fisheries and Aquatic Sciences 65:557-573).

3. How can we objectively assess the benefits of fish stocking in resident fish projects?

In diverse fish stocking programs under the Fish and Wildlife Program, fish are obtained from hatcheries entirely operated and maintained using BPA funds, obtained from existing state or federal hatcheries contracted using BPA funds, or purchased from commercial trout farms.

In the Resident Fish Review, the ISRP raised uncertainties, including (1) what stocking rates and schedules are justified based on ecological conditions[9] in the lake, reservoir, or stream, (2) what pre- and post-release performance metrics and standards for hatchery rearing should be met?

Metrics for hatchery performance should include life-stage survival, food conversion, fish condition, fish health inspections, and any required facility inspections for compliance for water quality discharge, and fish escapement. Performance metrics for post-release evaluations and monitoring should include fish growth and survival, fish condition, and yield to fisheries on a regular schedule, as part of a designed adaptive experimental program.

4. What management strategies (i.e., fish managed for large size and trophy fishery) might create fishing expectations that could conflict with goals for recovering native fish populations and harvest of those populations?

The biological consequences of creating angler expectations by managing for large fish should be given serious consideration. The ISRP has recommended that economic and social measures of benefit from these programs, including Tribal subsistence fisheries, also be developed and reported on a regular

[9] Social factors should also be considered. For example, immediate catch rates would be a factor. If a high percentage of put-and-take fish are harvested soon after stocking, and this is documented, the impacts on stocking beyond carrying capacity need to be assessed differently than in a situation with low immediate catch rates.

basis. Fish stocking programs should employ ecosystem modeling to improve their justification and to explore alternative sampling designs for post-release monitoring and evaluation (Askey 2007; PhD Thesis, University of Calgary, Calgary, Alberta).

5. What are the specific factors that may lead to the desirability and potential success of fish suppression projects?

The ISRP noted in the Resident Fish Review that, "A number of projects in the review involved suppression of non-native fish, especially lake trout and northern pike, in efforts to restore or maintain native species. Bioenergetic models are used to forecast how the suppression benefits populations of native species. Techniques to remove non-native fish include commercial gillnetting, bounties, harvesting brook trout to feed cultured fish, and sports fishing derbies. The ISRP observes that there are many common themes for the projects and suggests there is scope for increased coordination among them. Perhaps a special fish suppression meeting is needed to discuss the status of the projects, food web and ecosystem effects of non-native species removal and future orientation of research and monitoring. There is also scope for involvement with the IEAB [Independent Economic Analysis Board] given the projects are expensive and need funding for long time periods to maintain benefits. In some areas the economics of sport fishing on the non-natives enter into discussions as well."

6. How does density dependence, as manifested in stock recruitment relationships, affect proposed actions and outcomes?

A recent ISAB report on density dependence (ISAB 2015-1) has drawn more attention to this important topic and its role in fish and wildlife restoration. A more thorough understanding of stock-recruitment mechanisms in resident salmonids may benefit management of fishes in the non-anadromous portions of the Columbia River Basin. Recruitment relationships in resident salmonids that compare fluvial, adfluvial, and lacustrine life history types to recruitment relationships in anadromous salmonids deserve further research and investigation, as do implications to management. Although stock-recruitment mechanisms in anadromous fishes are not completely understood, they are much better defined than for resident fishes, and those anadromous mechanisms may not apply to resident fishes. For example, the shapes of the recruitment curves may differ because of different density dependent responses in resident than in anadromous fish. At the least, stock-recruitment relationships must be modified to accommodate the additional food and space requirements of resident adult forms, which typically co-occur with juveniles.

In the Resident Fish Review, the ISRP noted that "trout stocking projects are sometimes based on a limited understanding of carrying capacity and the potential effects on other fish species. Some fish stocking programs do not attempt to evaluate the potential effects of introduced hatchery fish on native salmonid and non-salmonid species. Most of the impacts would be likely to occur through predation or competition for both rearing space and food, but other interactions could take place as well, such as disease or parasite transmission. Additional impacts may occur from incidental bycatch of less productive native fishes when fishing for hatchery fishes."

For proposals that include planting hatchery fish or fertilized eggs in streams, there is a general lack of analysis of what the natural carrying capacity of the stream is and whether the stocking program would exceed the innate productivity of the drainage system. The ISRP also suggested that increased attention be given to the possible effect of stocking programs on non-target resident fishes, particularly in streams where spawning and rearing spaces are limited.

7. How can climate change considerations be explicitly incorporated into restoration planning in resident fish projects?

As the ISRP indicated in the Resident Fish Review, "as climate change models become better at predicting stream conditions, such as temperature and food webs, this information needs to be incorporated into planning documents and project actions. It makes sense to consider potential climate change impacts before committing substantial resources to improve habitat or manage invasive species in landscapes or waterscapes that may be inhospitable to the focal species in several decades. In addition, climate change models may identify regions that are overlooked today but might play an important role in providing persistence and resilience for native fishes such as bull trout, west-slope cutthroat trout, and whitefish."

In summary, as indicated in the recent Resident Fish Review (ISRP 2012-6), most of the resident fish programs involve a mix of habitat restoration activities, native trout species management, and non-native stocking programs. Often these efforts have mixed goals including, for example, both streams managed for native fish and closed system ponds stocked with triploid species for providing more immediate harvest. Many projects remain inadequately coordinated with other projects. Coordination and cost/time efficiencies might be gained if all resident fish activities were described, coordinated, and categorized by goal within a single umbrella Master Resident Fish Planning document for each area. For example, the ISRP noted that one topic that might benefit from such a coordinated approach would be the impacts of non-native stocking activities on native fish within the project areas, at a landscape scale.

Bull Trout in the Deschutes

200715700 - Bull Trout Status and Abundance on Warm Springs Reservation

Links to: project **and** reports

Proponent: Confederated Tribes of Warm Springs

Province/subbasin: Columbia Plateau/Deschutes

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Non-native and invasive species: To what extent do (or will) invasive and non-native species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?
- Population Structure and Diversity: What approaches to population recovery and habitat restoration are most effective in regaining meta-population structure and diversity that will increase viability of fish and wildlife in the Columbia River Basin?

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- What life histories of bull trout must be conserved to ensure persistence of a metapopulation?
- What are the impacts of brook trout on bull trout recovery efforts and how can they be mitigated?

Comment:

For both uncertainties listed, the relationship is indirect, in that the project is collecting data that could be used to inform the uncertainty.

Methods: Trends in bull trout abundance in tributaries of the lower Deschutes River were measured by monitoring long-term relative densities of juveniles by night snorkeling in index reaches and adults using redd counts. The diversity and extent of fluvial versus resident life histories were measured using weirs and traps, and antennas to detect trout marked with PIT tags. Growth rates are being measured from recaptures of PIT-tagged fish, although none are yet reported. Densities of nonnative brook trout juveniles were also measured in the index reaches.

Program Relevance and Project Results: Bull trout were listed as a threatened species under the ESA in 1998, and studies on populations on the Warm Springs Reservation of Oregon have been ongoing since then. Counts of adult bull trout redds have been declining in two main spawning streams since about 2002, some of which was attributed to floods and sediment from fires. Juvenile bull trout have declined over time in one of two streams with index reaches. Explanations may include competition with nonnative brook trout, which have increased slightly, degraded habitat, or difficulty of adults passing through weirs. The number of adult bull trout migrating upstream into two spawning tributaries has declined since about 2003. Both resident and fluvial life-history forms were identified from recaptures or detections of PIT-tagged bull trout.

Broad Applicability: Results could be applicable to bull trout metapopulations in other similar habitats, but reviewers felt that future work needs to be driven by clear hypotheses, in addition to data collection to estimate trends.

Time Required: The study could be refocused to address clear hypotheses during the next five year period. The project will be ongoing to collect data on populations through time.

The report was adequately written and the work described well, although greater synthesis in the final summary would have been helpful.

Freshwater Mussel Research

200203700 - Freshwater Mussel Research and Restoration

Links to: project **and** reports

Proponent: Umatilla Confederated Tribes (CTUIR)

Province/subbasin: Columbia Plateau/Umatilla

2006 Research Plan uncertainties addressed:

Direct:

- Fish Propagation: What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Monitoring and Evaluation (adaptive management): Can a common probabilistic (statistical) site selection procedure for population and habitat status and trend monitoring be developed cooperatively?

Indirect or Potential:

- Contaminants: How do toxic substances, alone and in combination, affect fish and wildlife distribution and abundance, survival, and productivity?

- Human Development: How might the projected changes under different development scenarios affect land use patterns, protection and restoration efforts, habitats, and fish and wildlife populations?
- Monitoring and Evaluation (adaptive management): Make best professional judgment, based on available data, as to whether any new research in the spirit of the Intensive Watershed Monitoring approach should be instigated immediately. Most new intensive research should arise as a result of the interaction of existing inventory data with new data arising in population and habitat status and trend monitoring.

Comment:

In most cases, the project is directly researching the many critical uncertainties listed, for freshwater mussels. The relation is indirect for uncertainties about contaminants and the need for Intensively Monitored Watershed studies.

Methods: Standard surveys, mark-recapture, and genetic techniques are used to evaluate mussel population dynamics. Artificial rearing and experimentation are being developed.

Program Relevance and Project Results: The program has strong relevance for the evaluation and recovery of native mussel populations. The partnership with Utah State University has been highly productive, and the proponents are reaching out to the best laboratories in North America conducting research on endangered mussels. The proponents are collecting considerable monitoring data, but it is not clear if general trends are emerging (other than the general state of individual populations). No trend analyses were noted in the report. Overall, the project seems to be in a discovery phase and may soon be moving to an experimental phase.

Broad Applicability: The data collected so far will be valuable for making management decisions to improve populations. If the project is successful, it will have very broad applicability. Proponents could collaborate with anthropologists who study shell mounds (kitchen middens) to understand past distribution and relative abundance of mussels. The research could also be expanded to other parts of the basin to understand mussel diversity, and even expanded beyond the basin.

Time Required: Long-term data are required to address repatriation success and propagation methods, given the long life span of mussels and the limited knowledge of ecological factors affecting mussel survival and reproductive success. The proponents will need at least another 5-8 years to demonstrate effectiveness.

Quality of Annual Report: The annual report was written in pieces by several parties, but overall it was comprehensive and suitable for understanding the critical uncertainties addressed.

Clearwater (Nez Perce Trout Ponds and Dworshak Dam)

199501300	Nez Perce Trout Ponds	Nez Perce Tribe
200700300	Dworshak Dam Resident Fish Mitigation	Idaho Department of Fish and Game (IDFG)

199501300 - Nez Perce Trout Ponds

Links to: project and reports

Proponent: Nez Perce Tribe

Province/subbasin: Mountain Snake/Clearwater

2006 Research Plan uncertainties addressed:

Direct:

- Contaminants: How do toxic substances, alone and in combination, affect fish and wildlife distribution and abundance, survival, and productivity?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- What land use actions can be implemented to result in improved water quality?

Comment:

Methods: water quality monitoring, creel census

Program Relevance and Project Results: A new critical uncertainty (i.e., one not addressed adequately in the 2006 Research Plan) is well described by the proponents:

"Ongoing water quality issues at Mud Springs Reservoir continue to challenge the viability of the trout fishery there so efforts to find a long term solution continue. Project staff are working with staff from NPT WRD and DFRM Watershed departments as well as county, state, and federal agencies and commercial professionals to find treatments that minimize the summer algal blooms at Mud Springs that threaten the trout fishery there on an annual basis. This unfortunately tends to be a 'Band Aid' approach that merely 'patches up' the symptomatic problems that appear on an annual basis, and though these 'fixes' can be less costly they do not address the underlying watershed-level land use issues that ultimately result in excess nutrients entering the watercourse and travelling downstream into Mud Springs Reservoir, resulting in marginal water quality conditions that continue to threaten the fishery. The comprehensive approach that is necessary for long term solutions will require adequate resources and cooperation among interest holders in the Mud Springs Pond and watershed area that result in better land use management."

Broad Applicability: This widespread issue is relevant at many locations in the basin where land use practices, often associated with agriculture, have led to water quality issues, especially summer algal blooms. Inputs may not necessarily all be toxic, but can lead to toxic conditions in the ponds

Time Required: The land/use/watershed actions leading to poor water quality will need to be addressed over a period of 5-10 years.

200700300 - Dworshak Dam Resident Fish Mitigation

Links to: project **and** reports

Proponent: Idaho Department of Fish and Game (IDFG)

Province/subbasin: Mountain Snake/Clearwater

2006 Research Plan uncertainties addressed:

Direct:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?

Indirect or Potential:

- Contaminants: How do toxic substances, alone and in combination, affect fish and wildlife distribution and abundance, survival, and productivity?
- Contaminants: What is the distribution and concentration of toxics, including emerging contaminants, in the Columbia River Basin, and what are/have been their trends over time?
- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?
- Non-native and invasive species: What is the current distribution and abundance of invasive and deliberately introduced nonnative species (e.g., the baseline condition), and how is this distribution related to existing habitat conditions (e.g., flow and temperature regimes, human development, restoration actions)?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Can kokanee abundance and production be increased through nutrient additions without detrimental declines in water quality?

Comment:

The objective of the project is to evaluate the effectiveness of nutrient restoration with a goal of restoring productivity to promote growth of edible phytoplankton, which will increase zooplankton and benefit fish populations (in particular kokanee). The project is measuring and reporting on results of limnological and food web sampling over time.

Methods: Details on calculation of picoplankton, phytoplankton, heterotrophic bacteria, and zooplankton were fairly limited. There were references to methods but that did not give a good feel for the uncertainty of the measurements (or the source of the uncertainty). Other methods seem to have sufficient detail. For example, standard techniques for monitoring limnological variables and the kokanee population were used. The project appears to yield statistically reliable results. Levels of precision are reported for limnological variables and measures of the kokanee population, but it is not evident if sampling intensity is sufficient to yield power necessary to obtain statistically significant results.

Program Relevance and Project Results: The project has clearly stated goals and quantifiable objectives. One goal is to restore lost productivity by improving the Nitrogen:Phosphorus ratios in the reservoir, thereby promoting the growth of desirable phytoplankton (i.e., edible by zooplankton). Objectives: (1) Maintain an annual median Secchi depth of ≥3.0 m and an annual median chlorophyll *a* concentration of ≤3.0 µg/L for treated areas of the reservoir; (2) Increase densities of picoplankton by twofold in the first year of nutrient restoration; (3)Increase the mean total length of age-2 kokanee by 20 mm over that observed at a similar pretreatment kokanee density; and (4) Maintain a kokanee population that can sustain a catch rate of 0.7 fish per hour with a minimum average size of 254 mm total length.

Data from 2003 to 2012 are presented to show trends. The project is to continue to 2017. Annual sampling provides indicators that will determine if the quantitative biological objectives are being attained. Nutrient restoration in Dworshak Reservoir shows some signs of success.

Broad Applicability: Applicability in many oligotrophic waters throughout the Columbia River Basin. The tradeoff between cold water fish production and water quality is an important issue in oligotrophic waters.

Time Required: Results of one year of treatment seem to show promising results. It may take 3-5 years or more to show conclusive results because many factors affect kokanee abundance and growth.

Middle Snake (Malheur and Owyhee)

199701900	Evaluate Life History of Native Salmonids in Malheur River Subbasin	Burns-Paiute Tribe
199501500	Duck Valley Reservation Reservoir Fish Stocking Operations and Maintenance (O&M)	Shoshone-Paiute Tribes

199701900 - Evaluate Life History of Native Salmonids in Malheur River Subbasin

Links to: project **and** reports

Proponent: Burns-Paiute Tribe

Province/subbasin: Middle Snake/Malheur

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?
- Non-native and invasive species: What is the current distribution and abundance of invasive and deliberately introduced nonnative species (e.g., the baseline condition), and how is this distribution related to existing habitat conditions (e.g., flow and temperature regimes, human development, restoration actions)?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Will it be possible to maintain genetically pure, self-sustainable resident populations of native trout and char (cutthroat trout, rainbow trout, redband trout, bull trout, etc.) in the face of naturalized populations of non-native trout, char, and other aquatic species; population fragmentation; habitat degradation; climate change; and other stressors?

Comment:

The most recent annual report was from 2013. The ISRP reviewers identified that information from the project might contribute to one 2006 uncertainty related to habitat and two 2006 uncertainties related to non-native and invasive species if the information was included in larger syntheses.

Methods: Clearly stated goals and quantitative objectives with timelines for achievements were not included in the report. The report describes four tasks related to Bull Trout management: (1) Bull Trout spawning survey report, 2013; (2) Selective removal of brook trout in Lake Creek, Upper Malheur River, Oregon; (3) Selective removal and risk assessment of Brook Trout in Meadow Fork Big Creek, Upper Malheur River, Oregon; and (4) 2013 stream temperature monitoring in the Upper Malheur Logan Valley Wildlife Mitigation Property. The visual survey technique used to assess for bull trout redds is a standard method used by fisheries managers, but estimates are subject to observer bias and variation in water clarity and discharge from year to year. Results of bull trout redd surveys are only applicable to monitoring bull trout in the Malheur River Subbasin. No measures of precision or accuracy were provided. Management efforts to remove brook trout using weirs and electrofishing were reported.

Program Relevance and Project Results: It was concluded that electrofishing was more efficient than weirs in the capture of brook trout. Results of brook trout removal efforts provide insight in the effectiveness of two methods that have potential applicability wherever introduced brook trout are affecting native salmonids in small streams; however, lasting positive effects will rely on consistent efforts when using mechanical methods. Stream temperature monitoring data indicated that high water temperatures in stream corridors and between lakes may be detrimental to bull trout reproduction and survivorship. Land use changes may have contributed to higher water temperatures.

Broad Applicability: The project findings have applicability to bull trout restoration efforts across the Columbia River Basin, especially in stream systems with non-native brook trout.

Time Required: Time required to complete the project cannot be estimated because long-term efforts will be required to preserve and restore bull trout populations in the subbasin.

199501500 - Duck Valley Reservation Reservoir Fish Stocking Operations and Maintenance (O&M) and Monitoring and Evaluation (M&E)

Links to: project **and** reports

Proponent: Shoshone-Paiute Tribes

Province/subbasin: Middle Snake/Owyhee

2006 Research Plan uncertainties addressed: None

Comment:

The most recent annual report was from 2013. Reviewers thought that the project might contribute to a 2006 uncertainty related to fish propagation, but it would only provide information regarding three locations where non-native fishes have been stocked. The project is important to the Shoshone-Paiutes Tribes as it partially mitigates for the loss of anadromous fishes on the Duck Valley Reservation (i.e., mitigation for anadromous fish blockage at Hells’ Canyon Dam). The project provides the Tribes access to resident fish in order to maintain a subsistence fishery. It also provides sport fishing for non-tribal members, which has economic benefits to the Tribes. It is not a research project designed to address uncertainties.

Methods: The Shoshone-Paiute Tribes reported annual management activities for three reservoirs on the Duck Valley Reservation. Goals and quantifiable objectives are not included in the report. No quantitative data are provided.

Program Relevance and Project Results: Management actions are implemented on an ad-hoc basis. For example, grass carp were introduced as a management action to reduce algae levels in the stocked reservoirs. It is not clear how, or if, problems with seasonally elevated water temperatures and low dissolved oxygen levels will be solved.

Broad Applicability: Lessons learned through the management of the small impoundments on the Reservation may provide insights to management of small impoundments in similar environmental settings of the Columbia River Basin.

Time Required: This is an ongoing subsistence/sport fisheries management project to benefit the Shoshone-Paiute Tribe. There is no end date.

Upper Snake (Fort Hall and South Fork)

199201000	Fort Hall Habitat Restoration	Shoshone-Bannock Tribes
200717000	South Fork Snake River Yellowstone Cutthroat Trout Recruitment and Survival Improvement	Idaho Department of Fish and Game (IDFG)

Summary

Both of these projects provided insights into the effectiveness of methods aimed at restoring populations of native cutthroat trout populations.

199201000 - Fort Hall Habitat Restoration

Links to: project **and** reports

Proponent: Shoshone-Bannock Tribes

Province/subbasin: Upper Snake/Snake Upper

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

New uncertainty:

- Will it be possible to maintain genetically pure, self-sustainable resident populations of native trout and char (cutthroat trout, rainbow trout, redband trout, bull trout, etc.) in the face of naturalized populations of non-native trout, char, and other aquatic species; population fragmentation; habitat degradation; climate change; and other stressors?

Comment:

The most recent annual report was from August 2013. Reviewers identified that information from the project might contribute to three 2006 uncertainties related to habitat if the information was included in larger syntheses.

The focus of this project is habitat enhancement, protection, and monitoring for native Yellowstone cutthroat trout in one stream on the Fort Hall Indian Reservation. Isolated populations of pure

Yellowstone cutthroat trout occur in numerous mountain streams, but are rare in spring streams. Spring Creek on the Fort Hall Bottoms, a large wetland adjacent to the Snake River near its entrance into American Falls Reservoir, provides unique habitat for this native fish. Stream banks were sloped in 2012 and 2013. Salmonid and interdependent species habitats were directly enhanced using a suite of stream bank restoration techniques in previous years such as willows, sedges, and rushes planted on the Bottoms. Clearly stated goals and quantitative objectives with timelines for achievements were not stated. This annual report described a relatively small-scale habitat restoration project for Yellowstone cutthroat trout residing in a spring creek on the Fort Hall Bottoms near American Falls Reservoir.

Methods: Limited trend monitoring had been conducted at the time of this report. The potential quality of the monitoring data was limited by failure to describe spatial sampling designs, locations of sampling sites, and habitat sampling techniques. Habitat was being monitored using sediment and depth surveys ("SADMS"), but no description of the method was provided. Fish populations were being monitored by electrofishing with two-pass depletion estimates of abundance, a technique that yields relatively imprecise estimates of abundance. Fry were being monitored by snorkeling, another method that yields relatively imprecise estimates of abundance. Fish harvest was being monitored by creel survey, but no description of the creel survey methods was provided. Very limited descriptions of fishery assessment methods were presented, thereby limiting repeatability into the future. No measures of variance were presented for either habitat or fish assessment metrics.

Program Relevance and Project Results: Limited trend monitoring had been conducted at the time of this report. No conclusions could be drawn regarding the benefits of the habitat enhancement efforts at the time of this report.

Broad Applicability: The project results may have broad applicability to restoration of cutthroat trout populations in the Columbia River basin, especially in low-gradient, spring-fed streams, if included in a large-scale synthesis of habitat restorations efforts for the species.

Time Required:
Responses of habitat and fish populations to the habitat manipulations in the spring stream may be anticipated in a reasonable amount of time (3-5 years).

200717000 - South Fork Snake River Yellowstone Cutthroat Trout Recruitment and Survival Improvement

Links to: project **and** reports

Proponent: Idaho Department of Fish and Game (IDFG)

Province/subbasin: Upper Snake/Snake Headwaters

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?
- Non-native and invasive species: What are the primary pathways of introduction of invasive and nonnative species, and what methods could limit new introductions or mitigate the effects of currently established invasives?

Additional uncertainty addressed or raised (not in the 2006 Research Plan):

- Will it be possible to maintain genetically pure, self-sustainable resident populations of native trout and char (cutthroat trout, rainbow trout, redband trout, bull trout, etc.) in the face of naturalized populations of non-native trout, char, and other aquatic species; population fragmentation; habitat degradation; climate change; and other stressors?

Comment:

The most recent annual report was from September 2013. Reviewers thought that information from the project might contribute to two 2006 uncertainties related to habitat if the information was included in larger syntheses.

Methods: This was a management project with the goal of creating genetically pure spawning populations of Yellowstone cutthroat trout in tributaries to the South Fork of the Snake River. Methods included weirs on four tributaries to prevent rainbow trout and rainbow trout x cutthroat trout hybrids from moving into spawning tributaries and removal of rainbow trout by electrofishing in the spawning tributaries. Quantifiable objectives with timelines were not provided. The methods described in the 2013 report were standard techniques used by fisheries managers. Trend data have been obtained, but the level of accuracy and precision of the data are uncertain. Removal efficiency for rainbow trout and hybrids was estimated by means of number of fish recaptured with marks, and estimates of rainbow trout abundance were made in streams above weirs.

Program Relevance and Project Results:
Project information should contribute to adaptive management. The proponents state that, "The tributary weir program has been successful at limiting RBT invasion into the four major Yellowstone cutthroat trout spawning tributaries of the South Fork Snake River." However, they acknowledge that "Regardless of the reason that the removals are not achieving the desired result, after four removals in three years, it now appears unlikely that continued removal efforts in Palisades Creek will result in a nearly pure Yellowstone cutthroat trout population in the foreseeable future. It appears unlikely that continued operation of weirs or removal efforts in tributaries will result in a nearly pure Yellowstone cutthroat trout spawning populations in the foreseeable future."

Broad Applicability: Results have applicability to management of native, resident cutthroat trout in tributary systems of the Columbia River Basin where naturalized populations of rainbow trout can hybridize with native cutthroat trout.

Time Required: Yellowstone cutthroat trout restoration using current methods will be a never ending process. There is no end date.

Banks Lake and Lake Rufus Woods

200102800	Banks Lake Fishery Evaluation	Washington Department of Fish and Wildlife (WDFW)
200740500	Rufus Woods Habitat/Passage Improvement, Creel and Triploid Supplementation	Colville Confederated Tribes

Summary

These two projects are involved with fish substitution efforts to develop viable fisheries, one for kokanee and the other for rainbow trout. In these projects, it is important that progress toward objectives be monitored. It remains unclear if kokanee is a viable species substitute in Banks Lake; other species may be more productive and may need to be considered.

200102800 - Banks Lake Fishery Evaluation

Links to: project **and** reports

Proponent: Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Columbia Plateau/Crab

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?
- Non-native and invasive species: What is the current distribution and abundance of invasive and deliberately introduced nonnative species (e.g., the baseline condition), and how is this distribution related to existing habitat conditions (e.g., flow and temperature regimes, human development, restoration actions)?

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- What is the feasibility of kokanee restoration in Banks Lake given the current habitat conditions (including existing species composition?
- Are there other fishery management directions that might produce greater benefits to the fishery in Banks Lake?
- In Banks Lake, how must populations of non-natives be altered in a quantitative way (specifically the competitor (lake whitefish) and predator (walleye)) to yield measureable benefits to the kokanee?

Comment:

The 2006 Research Plan uncertainties listed above are addressed but additional rigorous analyses would be desirable.

Methods: Standard water quality, zooplankton, and fish sampling methods were used. Measures of precision are provided for most of the summary statistics.

Misuse of linear regression analysis was noted when relationships between independent and dependent variables were computed. Means of dependent variables were used instead of all values in the sample. This increased the likelihood of statistically significant relationships and the amount of variance in the dependent variable accounted for by the model. Significant relationships are unlikely to persist with appropriate analyses.

Program Relevance and Project Results: Banks Lake is a highly atypical pump-storage reservoir with a kokanee fishery supported by annual stocking. The effects of a large one-time drawdown were assessed using data on water quality, zooplankton, and fish gathered before and after the drawdown. No significant differences were detected when comparing fish catch rates between the pre- and post-drawdown surveys.

General knowledge of the limnology of Banks Lake has improved. Factors limiting the success of the kokanee program have evidently been narrowed down to competition with lake whitefish, a non-native, and predation by bass and mostly walleye. At this point, this project would benefit from a more rigorous evaluation of potential competition and predation effects.

Broad Applicability: Perhaps applicable in a general way to kokanee populations region wide where interactions with non-native species in marginal habitats pose problems. However, the specific results have applicability mainly to Banks Lake.

Time Required: It is unclear whether objectives of this project can be met in the next 5-10 years.

200740500 - Rufus Woods Habitat/Passage Improvement, Creel and Triploid Supplementation

Links to: project and reports

Proponent: Colville Confederated Tribes

Province/subbasin: Intermountain/Columbia Upper

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?
- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Fish Propagation: What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles and from harvest in fisheries targeting hatchery-origin adults?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- What is the potential for stocking smaller fish and how will success relate to survival, stocking density, and non-native predators?
- Based on known physical and food web information in this run-of-the-river reservoir, are there realistic prospects for enhancing the rainbow trout fishery using anything but stocking (or escaping) of large, catchable-sized fish?

Comment:

Methods: A wide array of methods are used; extensive invertebrate sampling is conducted.

Program Relevance and Project Results: The work was conducted to provide insight into the best stocking strategies for rainbow trout. Then results suggest that the primary driver for the great success of the rainbow trout fishery was from fish that escaped from net pens; other catches were modest. Detailed site-specific data are presented, but little interpretation occurs that is specifically linked to stocking decisions. It remains unclear if a strong rainbow trout fishery can be maintained with a put and grow approach, or even a cost-effective put and take approach. More needs to be learned. A more focused, hypothesis-driven approach to answering key questions would be beneficial. The activities undertaken responded to requests for more information on food webs, but the links between food web research and stocking decisions are not clear at this time. If the food web data (e.g., primary and secondary production, fish production) cannot be related to potential carrying capacity of the system for raising trout, it will be of very limited value. This linkage has not been made thus far, and modeling efforts have not succeeded, evidently for lack of sufficient data. The reports are not up to date.

Broad Applicability: Additional information addressing the links between food web and specific trout stocking approaches would be useful at other locations. However, most results from this run-of-the-river reservoir will probably be of site specific value.

Time Required: If after perhaps three years the food web relations are not well worked out, they probably will remain unclear. The long-term (10 year) potential for improvement of the situation (other than escapees of fish from aquaculture) remains unclear.

Twin Lakes Enhancement

This is a very specific research project aimed at assessing the value of aeration as a management tool in small reservoirs. It was not designed to address any of the critical uncertainties in the 2006 Research Plan.

200811100 - Twin Lakes Enhancement

Links to: project **and** reports

Proponent: Colville Confederated Tribes

Province/subbasin: Intermountain/Columbia Upper

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Non-native and invasive species: What is the current distribution and abundance of invasive and deliberately introduced nonnative species (e.g., the baseline condition), and how is this distribution related to existing habitat conditions (e.g., flow and temperature regimes, human development, restoration actions)?

Comment:

The most recent report was from 2013. Reviewers thought that information from the project may contribute to one 2006 uncertainty related to non-native and invasive species, but only within the context of larger syntheses of information.

North Twin Lake and South Twin Lake exhibited poor year-to-year carryover of stocked and naturally recruited brook trout and rainbow trout, threatening the vitality of the most economically important lake fishery within the eastern portion of the Colville Confederated Tribes' Reservation. The long-term goal was to improve growth and survival of trout and create a put-grow-and-take trout fishery in the two lakes through hypolimnetic oxygenation.

Methods: To determine if hypolimnetic oxygenation systems would improve trout fisheries, a system was installed in North Twin Lake and measurements of water quality, food web, and fish abundance were compared in North Twin Lake before and after operation, and also to South Twin Lake which did not have a hypolimnetic oxygenation system. This study provides a good example of monitoring and assessment to evaluate effects of a management action. This was a well-designed assessment. Overall, objectives, hypotheses, sampling methods, and data analyses were thoroughly described. However, more detail on timing and frequency of some sampling efforts could have been included (e.g., what they are defining as “open season,” and frequency or dates of invertebrate sampling). Another limitation of the study was the assessment of harvest. A high quality data presentation showing statistically reliable results was reported. The data indicated more nutrient production, more habitat availability for trout, and increased food availability for trout in North Twin Lake with the hypolimnetic oxygenation system. However, trout abundance and body condition were not significantly increased and were not significantly different from South Twin Lake.

Program Relevance and Project Results:

The major conclusion was that there was no significant change in the trout fishery with hypolimnetic oxygenation.

Broad Applicability: The project results are specific to North Twin and South Twin lakes on the Colville Confederated Tribes’ Reservation, but the findings could be useful to managers of other reservoir trout fisheries in the Basin when considering management options.

Time Required: The project was completed and reported in a reasonable amount of time.

Lake Roosevelt and Tributaries

199700400	Resident Fish above Chief Joseph and Grand Coulee Dams	Kalispel Tribe
199104600	Spokane Tribal Hatchery Operations and Maintenance (O&M)	Spokane Tribe
199501100	Chief Joseph Kokanee Enhancement	Colville Confederated Tribes
200810900	Resident Fish Research, Monitoring and Evaluation (RM&E)	Colville Confederated Tribes
198503800	Colville Hatchery Operation and Maintenance (O&M)	Colville Confederated Tribes
199001800	Lake Roosevelt Rainbow Trout Habitat and Passage Improvement	Colville Confederated Tribes
199404300	Lake Roosevelt Data Collection	Spokane Tribe
200811500	Lake Roosevelt Burbot Population Assessment	Colville Confederated Tribes

199700400 - Resident Fish above Chief Joseph and Grand Coulee Dams

Links to: project **and** reports

Proponent: Kalispel Tribe

Province/subbasin: Intermountain/Columbia Upper

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?
- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Will it be possible to maintain genetically pure, self-sustainable resident populations of native trout and char (cutthroat trout, rainbow trout, redband trout, bull trout, etc.) in the face of naturalized populations of non-native trout, char, and other aquatic species; population fragmentation; habitat degradation; climate change; and other stressors?

Comment:

Information from the project is likely to contribute indirectly to two 2006 uncertainties related to (1) monitoring and evaluation and (2) non-native and invasive species if included in larger syntheses of information.

Methods: The goal the Joint Stock Assessment Project (JSAP) is to foster coordination among regional co-managers to help restore, conserve, and manage resident fish species occupying habitats above the Chief Joseph Dam. The most recent annual reports for this umbrella project describe the results and status of three sub-projects. The objective of one of these sub-projects is to ensure that historical and current fisheries data collected by the Colville Confederated Tribes are electronically preserved and available to regional co-managers, and when appropriate, provided to the Kalispel Tribes public database. Three objectives were stated: (1) organize historical paper datasheets and enter into computerized database for future preservation; (2) Coordinate with Colville Confederated Tribes project managers to compile and enter current habitat and fisheries data collected from lakes, streams, and reservoirs; and (3) Coordinate with Kalispel Tribe database specialists, provide QA/QC data for the GEDMS, and attend JSAP specific meetings and local and regional meetings.

The remaining two sub-projects make population assessments of native redband trout. One occurred in Big Sheep and Onion creeks. These streams enter the Columbia River above the northern end of Lake Roosevelt. In Big Sheep Creek, backpack electrofishing was used to capture redband trout to assess their abundance, rearing densities, and distribution. Genetic samples were also collected and are being analyzed by WDFW to test for genetic introgression with westslope cutthroat trout and introduced rainbow trout. Habitat attributes including stream width, substrate embeddedness, and dominant stream form (riffle, run, glide, pool, etc.) were measured at each sampling location. This report covered the fourth year of these surveys. Fish given PIT tags during surveys made in 2011-2013 were detected in 2014 suggesting a resident life-history form. Conversely, redband trout that had been PIT tagged in British Columbia were also detected in Big Sheep Creek indicating that some redband trout engage in lengthy freshwater migrations. An upstream-downstream weir with a box trap was installed in Onion Creek and used to estimate the number of adult redband trout spawning in Onion Creek. Estimates of fry and juvenile production were also made.

The third sub-project took place in the Spokane River. In this case, a capture-recapture procedure along with scale analyses were used to estimate redband trout abundance and year class strength in a 5.6 rkm index area.

Program Relevance and Project Results: The database established by the project will help co-managers assess the status of resident fishes in this part of the Basin. It may also prompt discussions among the co-managers about using common data collection methods and metrics. The redband trout assessments in Big Sheep and Onion creeks and the Spokane River along with similar efforts elsewhere in the upper Columbia River will provide information that can be used to track trends in their abundance and genetic diversity.

Broad Applicability: The database has the potential for informing statistical models and addressing uncertainties regarding factors affecting redband trout and other resident fishes within the Columbia

River Basin. Collaboration is needed among tribes and agencies working on redband trout. The methods being employed to estimate the abundance, year class strength, and migration patterns of redband trout could be employed in other parts of the Basin to address similar questions.

Time Required: It is reasonable to anticipate that the database will be completed within 3-5 years. Resident fish surveys will likely take longer.

199104600 - Spokane Tribal Hatchery Operations and Maintenance (O&M)

Links to: project **and** reports

Proponent: Spokane Tribe

Province/subbasin: Intermountain/Columbia Upper

2006 Research Plan uncertainties addressed: None

Comment:

This is an operations and maintenance project for the Spokane Tribal hatchery, which is focused on production of kokanee and rainbow trout as species substitutes. This project is designed for the hatchery to grow kokanee and rainbow trout for stocking. Production information is provided. It did not appear that any of the 2006 uncertainties are explicitly addressed.

Project activities are not developed in the context of answering questions, but toward raising fish. In the summary report, there are recommended changes in hatchery production schedules, but rationales for those changes are not provided.

199501100 - Chief Joseph Kokanee Enhancement

Links to: project **and** reports

Proponent: Colville Confederated Tribes

Province/subbasin: Intermountain/Columbia Upper

2006 Research Plan uncertainties addressed:

Direct:

- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?

Indirect or Potential:

- Climate Change: Can indices of climate change be used to better understand and predict interannual and interdecadal changes in production, abundance, diversity, and distribution of Columbia Basin fish and wildlife?
- Climate Change: Can integrated ecological monitoring be used to determine how climate change simultaneously affects fish and wildlife and the freshwater, estuarine, ocean, and terrestrial habitats and ecosystems that sustain them?
- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: What are the impacts of hydrosystem operations on mainstem habitats, including the freshwater tidal realm from Bonneville Dam to the salt wedge? How might hydrosystem operations be altered to recover mainstem habitats?

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- What are effects of entrainment through dam on success of the kokanee program?
- What are the potential effects of non-native species on the success of the kokanee project? How can those effects be ameliorated? [The non-native removal reduced numbers of them, but effects on kokanee were not presented.]
- How might climate change affect the success of the kokanee program as waters warm, favoring other species, especially non-natives? Are kokanee the best choice for substitution species in this situation?
- What is the origin and spawning location of Lake Roosevelt wild kokanee? How can that spawning be enhanced?

Comment:

Several ISRP programmatic comments on resident fish apply strongly to this project.

Methods: A wide range of methods are used in this multifaceted study, including egg plants, larval sampling, weirs traps, adult electrofishing and gillnetting, genetics, and otolith microchemistry.

Program Relevance and Project Results: This project is designed to develop and protect self-sustaining populations of kokanee that will contribute to tribal subsistence and non-tribal recreational fisheries

Broad Applicability: The project will be addressing questions of broad ecological significance in the basin in coming years.

Time Required: It may take years to sort out the factors limiting kokanee abundance in this system.

200810900 - Resident Fish Research, Monitoring and Evaluation (RM&E)

Links to: project **and** reports

Proponent: Colville Confederated Tribes

Province/subbasin: Intermountain/Columbia Upper

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?
- Non-native and invasive species: What is the current distribution and abundance of invasive and deliberately introduced nonnative species (e.g., the baseline condition), and how is this distribution related to existing habitat conditions (e.g., flow and temperature regimes, human development, restoration actions)?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Will it be possible to maintain genetically pure, self-sustainable resident populations of native trout and char (cutthroat trout, rainbow trout, redband trout, bull trout, etc.) in the face of naturalized populations of non-native trout, char, and other aquatic species; population fragmentation; habitat degradation; climate change; and other stressors?

Comment:

The most recent annual report was from 2013. Information from the project is likely to contribute indirectly to two 2006 uncertainties related to non-native and invasive species. The focus of the project is to conserve, enhance, and restore redband trout in the Sanpoil River drainage, a major tributary to the Columbia River above Grand Coulee Dam.

Methods: The stated objectives were (1) monitor recruitment of juveniles from the Sanpoil River into Lake Roosevelt; (2) monitor adult escapement into the Sanpoil River; (3) summarize wild trout harvest in the lower third of Lake Roosevelt; (4) monitor in-river movements to identify seasonal patterns, spawning locations, and key overwintering habitat use; (5) monitor spatial and temporal reservoir movement patterns of adult redband trout; (6) and implement a redband trout genetic study. The stated objectives suffer from not being quantitative and not having temporal endpoints. Sound methods appear to have been used among the array of tasks, and statistically reliable results were reported. Measures of precision were reported for most of the statistics presented.

Program Relevance and Project Results: The project provides data with potential for use in adaptive management of redband trout.

Broad Applicability: While the information is applicable to redband trout in the Sanpoil River and Lake Roosevelt, it has the potential for use in the preservation of redband trout throughout its range in the Columbia River Basin.

Time Required: Needed duration of the project is indeterminate because such native fish restoration projects are very long term efforts.

198503800 - Colville Hatchery Operation and Maintenance (O&M)

Links to: project **and** reports

Proponent: Colville Confederated Tribes

Province/subbasin: Intermountain/Sanpoil

2006 Research Plan uncertainties addressed: None

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- How can continued stocking of brook trout, which supports fisheries, be ecologically defended with its status as an undesirable invasive in many portions of the region? What is the effect, if any, of these non-natives on the native fish restoration efforts?

Comment:

This is an operations and maintenance (O&M) project for the Colville Tribal hatchery program, which is based on production of redband trout as well as rainbow trout, brook trout, and Lahontan cutthroat trout as species substitutes. However, in the annual report there is also reporting on abundance and condition of fish in the creel, as well as an effort to match stocking with capacity of the waters and improving water quality in selected waters. There is also work on oxygenation needs for one lake.

The report discusses stocking and creel activities, and mentions an effort to shift toward native fish in stocking programs, but is mostly task oriented and not focused on answering specific uncertainties.

Broader significance: Broader significance cannot be easily gleaned from this task-oriented report. The reporting would benefit from a more critical evaluation and presentation in terms of specific goals for particular tasks undertaken. Most of the material presented has no context for a reviewer to evaluate progress.

Timeframe: Redband broodstock development and improvements in rearing success may take 5-10 years. In the meantime, the rest of the project could benefit from an evaluation of activities in the context of a well-focused plan with clear goals more carefully articulated beyond “better fishing.” Additional consideration of and justification for species selection may be warranted.

199001800 - Lake Roosevelt Rainbow Trout Habitat and Passage Improvement

Links to: project **and** reports

Proponent: Colville Confederated Tribes

Province/subbasin: Intermountain/Sanpoil

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

Comment:

Methods: This project makes use of standard methods to be compatible with other M&E efforts such as CHaMP. Fish sampling emphasizes three-pass electrofishing. Water temperature and discharge are monitored via typical methods.

Program relevance and brief summary of findings: Deliverables are clearly presented in the report.

The project is not specifically designed to address uncertainties. However, one critical uncertainty specific to this project is how effectively EDT can actually be used to prioritize restoration actions and to predict salmonid production in this case study. A second uncertainty is the actual benefits to fish. In a previous review, the ISRP identified the following uncertainty, which has not been clarified as of the latest report:

“...the sponsors expressed some uncertainty about whether information obtained from the fish monitoring project can be used in conjunction with habitat monitoring information to determine whether habitat enhancement is benefiting fish, an important consideration since the primary purpose of the habitat work is to improve fish populations. Both are very fine projects, but at this point there seems to

be little functional relationship between them. The ISRP encourages the sponsors of both projects to work together to determine how fish and habitat sampling can be coordinated to address the critical question of whether habitat enhancement is benefiting focal species. Both projects also need to focus on the unraveling of resident trout life history and recruitment mechanisms, as well as life-history-based limits to production, to assure (i.e., experimentally test) that these limits will be adequately addressed with rehabilitations."

Another uncertainty is the potential role of non-natives in the Sanpoil River and Lake Roosevelt (e.g., smallmouth bass, walleye) in affecting the productivity of adfluvial fish.

Broad Applicability: The authors note that pre-2012 habitat surveys did not collect explicit spatial data which limits the utility of those data. The project is not framed in a broad ecological context beyond that already encompassed in EDT. The work is not hypothesis driven. It is mostly extensive data collection. There appears to be very little attempt at meaningful synthesis at this point.

Time Required: Methods have changed as knowledge and capabilities of project staff develop. Future progress may occur more rapidly as a result. A future uncertainty is how the social and cultural issues related to road decommissioning and cattle fencing will be resolved.

199404300 - Lake Roosevelt Data Collection

Links to: project **and** reports

Proponent: Spokane Tribe

Province/subbasin: Intermountain/Columbia Upper

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?
- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Fish Propagation: What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles and from harvest in fisheries targeting hatchery-origin adults?

Comment:

Several ISRP programmatic comments for resident fish are relevant to this project.

Methods: The project monitors walleye with the intention of taking management action to improve the condition of resident kokanee. Possible negative effects on kokanee populations are not clearly explained. A 2013 survey of redband trout and their habitat in the Kettle River watershed utilized sound methods that were well documented in the annual report. Measures of precision were presented for abundance estimates and where means were computed. The data documentation is very good.

The authors state that "Stock assessment data will eventually be used to evaluate and model potential management alternatives to ensure healthy redband populations." The data is of a quality to provide sound indicators and inform statistical models.

Program Relevance and Project Results: A critical uncertainty, at a programmatic level, is whether the objectives of the program, especially those related to restoration of coldwater species, are all consistent with the realities of a novel, mostly cool-water ecosystem. This is a long-standing uncertainty. In the most recent past review, the ISRP *"expressed concern about whether it is reasonable to establish a viable kokanee fishery lake-wide given the complex problems limiting kokanee in the reservoir.*" This concern is still valid. The results indicate a very limited kokanee fishery despite years of effort.

Broad Applicability: The Columbia River redband trout is a subspecies of rainbow trout native to the Columbia River drainage east of the Cascade Mountains extending upstream as far as barrier falls on the Snake, Spokane, Pend Oreille, and Kootenai rivers. Little is known about redband trout in Lake Roosevelt and the upper Columbia River. The ecological results have applicability to management throughout the subspecies distribution.

Some applicability of project results may be restricted to Lake Roosevelt due to the unique nature of the physical and biological features as well as dam operations.

Time Required: The annual report proposes that most activities continue indefinitely. The 2013 survey is part of a multi-agency effort to assess redband trout stocks in Lake Roosevelt and the upper Columbia River that will require many years to complete.

200811500 - Lake Roosevelt Burbot Population Assessment

Links to: project **and** reports

Proponent: Colville Confederated Tribes

Province/subbasin: Intermountain/Columbia Upper

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Harvest: What new harvest and escapement strategies can be employed to improve harvest opportunities and ecological benefits within the Columbia Basin while minimizing negative effects on ESUs or populations of concern? Can genetic techniques be used to quantify impacts on wild or ESA-listed stocks in ocean fisheries?

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- In view of burbot's decline in many locations, how plausible is it to develop and promote fisheries for them?
- What are the factors that limit burbot abundance and sustainability?
- In a comparative approach among populations, what factors are allowing burbot to thrive in some areas but causing them to decline in others?
- Is fall gillnetting for walleye suitable for monitoring walleye?

Comment:

Methods: Use of data collected through the Lake Roosevelt Fall Walleye Index Netting (FWIN) surveys was suggested by the ISRP as a means to monitor burbot. In 2013, a subcontractor analyzed 10 years of FWIN data (2003-2012) and assessed its adequacy for burbot stock assessment. In 2014, another contractor conducted further analyses with additional data collected in 2013. The stock assessment indices evaluated were relative abundance, mortality, recruitment, size and age structure, growth, condition, sex ratio, and reproductive development. Power was calculated for all statistical tests. Most indices had high power to detect changes thought to be biologically significant, although high variability resulted in relatively low power to detect changes in catch rate and mortality. The analyses indicate that the FWIN data can be used to monitor Lake Roosevelt Burbot.

Program Relevance and Project Results: In many localities, burbot are struggling in their native habitat of the Wind/Bighorn River, but are expanding in some areas (e.g., in the upper Green River) where they have been illegally introduced. Burbot are considered to be at high risk for overharvest wherever fisheries occur within their native range. Water development and other factors are contributing to their declines and there is a need for adequate stock assessment data in many locations throughout their native range.

Broad Applicability: Lake Roosevelt is one of 11 lakes and reservoirs within the Columbia River drainage in Washington State that supports a burbot population. Standardized stock assessment data are needed to facilitate management of the burbot populations in the Columbia River Basin and outside the basin. Other potential applications will exist outside of the basin.

Time Required: It will take some years to develop a carefully monitored fishery for burbot.

Coeur d’Alene and Spokane

199004400	Coeur d’Alene Reservation Fisheries Habitat	Coeur d’Alene Tribe
200103200	Coeur d’Alene Fisheries Enhancement-Hangman Creek	Coeur d’Alene Tribe

Summary

These projects focus on restoration of native trout populations and represent management efforts, but they were not designed to address critical uncertainties.

199004400 - Coeur d’Alene Reservation Fisheries Habitat

Links to: project **and** reports

Proponent: Coeur d’Alene Tribe

Province/subbasin: Intermountain/Coeur d’Alene

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?
- Non-native and invasive species: What is the current distribution and abundance of invasive and deliberately introduced nonnative species (e.g., the baseline condition), and how is this distribution related to existing habitat conditions (e.g., flow and temperature regimes, human development, restoration actions)?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Will it be possible to maintain genetically pure, self-sustainable resident populations of native trout and char (cutthroat trout, rainbow trout, redband trout, bull trout, etc.) in the face of naturalized populations of non-native trout, char, and other aquatic species; population fragmentation; habitat degradation; climate change; and other stressors?

Comment:

The most recent annual report was from June 2013. Information from the project might contribute indirectly to three 2006 uncertainties related to habitat and two 2006 uncertainties related to non-native and invasive species if the information was included in larger syntheses.

This project focuses on adfluvial and fluvial cutthroat trout on the Coeur d'Alene Reservation. It is divided into two sections: (1) monitoring and evaluation and (2) implementation of restoration and enhancement projects.

Methods: Clearly stated goals and quantitative objectives with timelines for achievements were not stated. The proponents apply a variety of standardized methods used in fisheries science to assess adfluvial and fluvial cutthroat trout and their responses to management actions on the Coeur d'Alene Reservation. Numerous standard indicators with measures of precision are being reported. The information on spawners, juvenile abundance, introduced brook trout, and habitat in the study area provide a baseline for tracking progress into the future.

Program Relevance and Project Results: This project report provides data on abundances, length frequencies, and body conditions of spawning adfluvial cutthroat trout in Lake and Benewah creeks; juvenile cutthroat trout outmigration from the two creeks; status and spatial distributions of cutthroat trout in Evans, Alder, Lake, and Benewah creeks; stream temperatures and habitat features in the Lake and Benewah watersheds; effectiveness of artificial log jams; effectiveness of brook trout removal efforts; and the restoration actions implemented in the upper mainstem of Benewah Creek.

Broad Applicability: The information provided is broadly applicable to restoration and management of adfluvial and fluvial native cutthroat trout throughout the Columbia River Basin.

Time Required: Time required to complete the project cannot be estimated because it is a long term effort to preserve and restore cutthroat trout populations.

200103200 - Coeur d’Alene Fisheries Enhancement-Hangman Creek

Links to: project **and** reports

Proponent: Coeur d’Alene Tribe

Province/subbasin: Intermountain/Spokane

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Will it be possible to maintain genetically pure, self-sustainable resident populations of native trout and char (cutthroat trout, rainbow trout, redband trout, bull trout, etc.) in the face of naturalized populations of non-native trout, char, and other aquatic species; population fragmentation; habitat degradation; climate change; and other stressors?

Comment:

The most recent annual report was from April 2013. Information from the project might contribute indirectly to three 2006 uncertainties related to habitat if the information was included in larger syntheses.

Methods: The primary goal of the project was to protect and/or restore stream habitats throughout the Hangman Watershed on the Coeur d’Alene Indian Reservation in order to support the restoration or reintroduction of native fishes, particularly redband trout. The goal was to be attained through a process using the following steps: (1) conduct baseline investigations to determine native and resident fish stock composition, distribution, and relative abundance in the subbasin by year 2010 (Intermountain Province Subbasin Plan 2004); (2) describe biological, physical, and chemical attributes of habitat of Hangman Creek and its tributaries that either support or limit the distribution and abundance of native redband trout; (3) protect and enhance native redband trout populations by implementing habitat restoration measures; (4) create a holistic approach to restoration through a public outreach program; and (5) create a fishery to support traditional and recreational harvest. However, clearly stated quantitative objectives with a timeline for achievement of goals were not presented. The project proponents have applied sound methods used by fisheries scientists that tend to yield reliable results. Levels of precision have been reported for appropriate metrics. Tests of accuracy of indices of trout abundance have been conducted to show a strong relationship between estimates of abundance in stream reaches and estimates of abundance by single-pass electrofishing used in monitoring. Methods were well described so that they can be repeated into the future.

Program Relevance and Project Results: Outstanding trend monitoring data are being collected that provide sound tracking of project goals. The project began in 2002. The 2013 report described the status and trends of redband trout populations, water quality, hydrology, and fish habitat in the targeted sub-watersheds, as well as a summary of restoration projects and the physical and biological responses associated with them. An exceptionally good synthesis of findings was presented. The M&E data were reported in a way that is highly relevant to adaptive management process.

Broad Applicability: The project results have widespread applicability to preservation and restoration of resident native trout populations in watershed that are tributary to the Columbia River, and especially to redband trout.

Time Required: It is not evident when the project will be completed, but restoration efforts for native fishes generally require long-term efforts.

Albeni Falls

200724600 - Restoration of Bull Trout Passage at Albeni Falls Dam

Links to: project **and** reports

Proponent: Kalispel Tribe

Province/subbasin: Intermountain/Pend Oreille

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Population Structure and Diversity: What approaches to population recovery and habitat restoration are most effective in regaining meta-population structure and diversity that will increase viability of fish and wildlife in the Columbia River Basin?

Additional uncertainty addressed or raised (not in the 2006 Research Plan)

- How much spawning site fidelity do bull trout actually show (in this system and in general) and what are the factors affecting the degree of fidelity?

- Will it be possible to maintain genetically pure, self-sustainable resident populations of native trout and char (cutthroat trout, rainbow trout, redband trout, bull trout, etc.) in the face of naturalized populations of non-native trout, char, and other aquatic species; population fragmentation; habitat degradation; climate change; and other stressors?

Comment:

Methods: Adult bull trout were captured below Albeni Falls Dam. Captured fish were DNA sampled, equipped with a radio tag and subsequently released above the dam. The DNA samples were used to determine the most likely upstream tributary population each fish originated from. The radio tags were used to see if the tagged fish returned to their apparent natal tributary. The fish collection, trap and haul, genetic identification, and telemetry methods used are well established.

Program Relevance and Project Results: Since 2004, 21 bull trout have been captured, DNA sampled, and radio tracked. Seventeen of the fish migrated into Lake Pend Oreille and 6 of those were found to enter predicted tributaries and 2 others entered secondary natal tributaries. Two additional fish entered non-predicted tributaries. The investigators state that genetic assignments for regions are highly accurate for bull trout, but they are less accurate for specific tributaries.

Broad Applicability: The overall approach is appropriate given the logistics of the site, in the absence of fish passage. The approach is similar to that practiced at Cabinet Gorge Dam on the Clark Fork River. However, the long term effectiveness of this approach in restoring the species is not clear. The small number of fish actually tagged and the even smaller number able to be traced to a tributary limit the value of the results of this study.

Time Required: Either effective passage will need to occur or trap and haul will need to be sustained into the future. Long term prognosis for success is unclear.

Pend Oreille

199404700 - Lake Pend Oreille Kokanee Mitigation

Links to: project **and** reports

Proponent: Idaho Department of Fish and Game (IDFG)

Province/subbasin: Intermountain/Pend Oreille

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Mainstem Hydrosystem Flow and Passage Operations: What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?
- Mainstem Hydrosystem Flow and Passage Operations: What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species and stocks? What are the ecological effects of hydrosystem operations on downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?
- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?

Comment:

Methods: Sound standardized methods adequate to the task are being used to monitor targeted fish populations and Mysids. Statistically reliable results are being obtained and a long time series of annual data have developed. Measures of precision are provided for abundance and density estimates.

Program Relevance and Project Results: Data in this focused study suggest that a combination of predator control and water level management may be necessary for recovery of kokanee.

It remains uncertain, however, as to the relative effects of reservoir operations and predator control on kokanee. The project is producing quality data that can be used to address these uncertainties for Lake Pend Oreille and other reservoirs.

The long-term data sets on fish populations, prey, and habitat enable the tracking of quantitative biological objectives and have the potential to inform statistical models.

Broad Applicability: The project has high applicability throughout region in terms of effects of predator control and water level management. It is applicable to reservoirs where sport fisheries for kokanee are being managed in the Columbia River Basin and throughout western North America. Relative values of managing reservoir elevations and predator control are yet to be determined in most of these waters. Bull trout are native to the watershed and are particularly susceptible to lake trout predation. While bull trout are not mentioned in the project objectives, information from this project is pertinent to efforts to recover this listed species in the Columbia River Basin.

Time Required: Long-term management of reservoir operations and control of predators is needed to maintain a fishery for kokanee. Continual maintenance control of predators and water level management may be required for the desired outcome.

Kootenai

198806500	Kootenai River Fishery Investigations	Idaho Department of Fish and Game (IDFG)
199404900	Kootenai River Ecosystem Restoration	Kootenai Tribe
199500400	Libby Reservoir Mitigation Restoration and Research, Monitoring and Evaluation (RM&E)	Montana Fish, Wildlife and Parks (MFWP)

Summary

These projects are components of what is one of the most *ecologically* complex programs in the Fish and Wildlife Program, designed to restore ecosystem function on the Kootenai River. Although the scope and complexity of the effort are recognized in the reports, effective achievement of the “overall goal” will require effective implementation and adequate measurement of appropriate indicators of the changes in ecosystem function. This requirement applies especially to 1994-049-00. The other two projects are more specific and metrics should be easier to identify.

198806500 - Kootenai River Fishery Investigations

Links to: project **and** reports

Proponent: Idaho Department of Fish and Game (IDFG)

Province/subbasin: Mountain Columbia/Kootenai

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: What are the impacts of hydrosystem operations on mainstem habitats, including the freshwater tidal realm from Bonneville Dam to the salt wedge? How might hydrosystem operations be altered to recover mainstem habitats?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Mainstem Hydrosystem Flow and Passage Operations: What are the optimal temperature and water quality regimes for fish survival in tributary and mainstem reaches affected by dams, and are there options for hydrosystem operations that would enable these optimal water quality characteristics to be achieved? What would be the effects of such changes in operations and environment on fish, shoreline and riparian habitat, and wildlife?
- Mainstem Hydrosystem Flow and Passage Operations: What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species and stocks? What are the ecological effects of hydrosystem operations on downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?
- Mainstem Hydrosystem Flow and Passage Operations: What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?

Comment:

Methods: Several activities are implemented under the objective of determining environmental requirements for spawning and recruitment of white sturgeon, including monitoring responses to flow augmentation, nutrient fertilization, hatcheries, and effects of substrate on cannibalism, among others, across a variety of species (sturgeon, salmonids, burbot).The methods for both the management actions and the monitoring are well described.

Standard fishery methods used to evaluate the status of sturgeon and burbot populations. A hatchery is used for rearing and out planting of juvenile burbot. Nutrient additions to the main river are the main effort used to improve the abundance and relative weights of rainbow trout and whitefish.

The experiments follow study methods that make evaluation of impact feasible. For example, fertilization experiments downstream of Libby Dam were conducted to evaluate the effect on increasing productivity. The study design included electrofishing upstream and downstream (control and treatment) to calculate various metrics and for application in growth models.

Program Relevance and Project Results: This program is attempting to mitigate the effects of the construction of Libby dam on sturgeon, burbot, rainbow trout and whitefish (HLI: resident fish) in the Kootenai River. While the program (including monitoring) is well conducted, the results are generally disappointing. Burbot and whitefish are showing some slight positive responses. Sturgeon are not responding (no successful recruitment), and rainbow trout results remain equivocal.

The proponents suggest that they have an understanding of the substrate and recruitment problem. However, in a previous review, the ISRP concluded that uncertainty remains. This conclusion remains valid. The hypothesis forwarded by the proponents as to why sturgeon are not recruiting well, in terms of substrate, is plausible and well worth testing, but not proven. It is unclear why sturgeon would repeatedly spawn over finer substrate when natural river processes might suggest that if they went farther upriver, as they are able to do, they might find larger substrate, and that such behavior might not have been selected for. Another hypothesis perhaps worth considering is that because of energetics, the largest, oldest sturgeon, in this case wild fish, may remain farther downriver, whereas smaller younger hatchery fish, both mature and immature, may move farther upriver. If so, as the hatchery fish mature, they may spawn farther upriver over the more desirable substrates. This pattern has been observed repeatedly in other species, and it may explain why some hatchery fish are moving upriver into Montana whereas the older fish typically have not. Besides substrate, recruitment may also be hindered by slow growth rates as a result of cooler summer waters and loss of slightly off-channel habitats (e.g., side channels) associated with river regulation and floodplain loss. Knowledge of factors affecting recruitment success is the critical uncertainty for the success of this project. The same critical uncertainty applies to the burbot, although the factors limiting recruitment may differ.

The activities reflect a research program that addresses uncertainties around hatcheries, habitat (substrate and nutrients), and flows. A variety of types of results are reported:

- fish per rod hour for angling and fish per setline hour
- collected eggs from substrate mats
- number of days spawned
- discussion of spatial distribution of results
- length and weight of fish
- survival and growth rates of wild vs. hatchery fish (burbot)
- timing of burbot migration

Key findings are clearly stated by species. For example, key findings surround the status and extent of sturgeon and the impacts of flows on sturgeon spawning success.

Project results are produced in a timely manner, but data are stored locally on a data server with limited access to the public. It is shared among collaborators and by request. Is this the most effective way of disseminating results?

Broad Applicability: If the proponents can effectively identify specific limiting factors and the exact mechanisms, it would probably have some applicability to other situations in the Basin and beyond. Thus far, though, the results are not especially encouraging regarding the importance of any single action or technique. If any of the programs actions were to be successful, then they would have broad applicability. In the meantime, others can learn from the approaches used.

Linking the nutrients work specifically to the sturgeon and burbot recruitment problem would be very beneficial.

Time Required: The project has a good record of reporting results in a timely manner. Further, by its nature, this is a long term project that was initiated in 1988 (~27 years ago). The current research activities have been in place for about a decade. The burbot and sturgeon investigations require a substantial amount of time in order to demonstrate trends. These studies should be ready for detailed evaluations in 2016. The nutrient addition investigation should be evaluated at the same time to see if it has been effective, although trends so far have not been overly impressive.

A fishery for burbot in 2017 seems overly optimistic, especially when factors affecting recruitment are not well understood.

199404900 - Kootenai River Ecosystem Restoration

Links to: project **and** reports

Proponent: Kootenai Tribe

Province/subbasin: Mountain Columbia/Kootenai

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat - To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat - What are the impacts of hydrosystem operations on mainstem habitats, including the freshwater tidal realm from Bonneville Dam to the salt wedge? How might hydrosystem operations be altered to recover mainstem habitats?

Comment:

This project focusses directly on water chemistry and algal population dynamics associated with artificial nutrient additions to the Kootenai River. Fish and invertebrate responses are addressed in separate project reports.

Methods: The proponents used standard methods to evaluate nutrient (N, P) and Dissolved Organic Carbon (DOC) concentrations, algal community composition, and algal accrual rates at several points along the river. Sampling included reference and treatment sites.

Program Relevance and Project Results: The project has important relevance for understanding how the effects of Libby Dam on nutrient supplies can be mitigated. The proponents conduct a thorough monitoring program to delineate longitudinal trends in nutrient and DOC concentrations – but tributary inputs and micro-nutrients (e.g., silica) are not monitored. Benthic invertebrates are reported on in a separate report, where Minshall et al. (2014; Freshwater Science 33:1009-1023) found that benthic invertebrate biomass increased immediately below the dosing site but community structure remained unchanged. In a 2012 evaluation, the ISRP indicated that "The proposal, and the response to questions raised, did not adequately address the ISRP specific major concern about the need for a model, or some other method, of integrating data being collected to evaluate the response of the river ecosystem to nutrient addition. A mechanism for synthesizing data would allow hypotheses about river response to nutrient enhancement to be refined through time and the monitoring protocols to be modified accordingly."

Broad Applicability: The results are positive for a short section of river (~1 rkm) immediately below the dosing station. The broad applicability of this approach is limited by the amount of key nutrients needed by the river and the number of dosing stations that would be required for an ecosystem-scale response.

Time Required: The initial experiment and the biotic responses have sufficient data to evaluate the utility of the approach. Reviewers do not see a need to conduct further methodological research without a fundamental change in broadening the scope of the program to an ecosystem level. This is a large, complex project that will optimistically take 10 years at an ecosystem response scale.

199500400 - Libby Reservoir Mitigation Restoration and Research, Monitoring and Evaluation (RM&E)

Links to: project and reports

Proponent: Montana Fish, Wildlife and Parks (MFWP)

Province/subbasin: Mountain Columbia/Kootenai

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What are the impacts of hydrosystem operations on mainstem habitats, including the freshwater tidal realm from Bonneville Dam to the salt wedge? How might hydrosystem operations be altered to recover mainstem habitats?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Mainstem Hydrosystem Flow and Passage Operations: What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species and stocks? What are the ecological effects of hydrosystem operations on downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?
- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- What are the measureable responses to river fertilization and how do those changes affect aquatic community structure and management for productive fisheries?
- How do riparian revegetation efforts affect changes in fish and wildlife species composition inhabiting those areas?
- What are the factors affecting accuracy and precision of redd surveys? Can these surveys be improved, and if so, how? Are fine sediments a limiting factor for bull trout abundance and recovery, and if so, where?
- What are the factors affecting accuracy and precision of redd surveys?
- What are the non-harvest factors affecting burbot abundance?

Comment:

This is a complex, multifaceted project of both operational and non-operational mitigation that includes fish and reservoir monitoring, stream restoration, innovative research (e.g., *Didymo* control), cooperative investigations (e.g., Kootenai River fertilization), installing fish screens, developing watershed plans with partners, and conducting riparian re-vegetation and maintenance. This phase of the project (III) has been in place since 1996 and evolves in response to prioritization of opportunities and emerging challenges. Their annual report was very thorough and well prepared.

Methods: This is a complex conglomerate of work elements with a wide range of methods. Specific standard methods are used, as appropriate for the type of project. It is yielding statistically reliable results.

The statistical methods (e.g. BACI design, mark recapture, etc.) are generally reliable, and the authors rightfully acknowledge that detecting population-level response is not feasible due to the high variability of the populations and intra-species interactions. The authors also note that, for these reasons, the results are likely not generalizable. Under these conditions, the value in monitoring population-level responses with the current approaches need to be justified.

Furthermore, several elements of this work are more of a status-and-trends monitoring project than a response-to-restoration/mitigation project. Some elements are clearly oriented around response to mitigation (e.g. U of Idaho research on P fertilization as a control mechanisms for *Didymosphenia. geminata*), but it seems that many are not. For example: "Researchers are hopeful that the observed annual variability in survival and growth of trout can be attributed analytically to important biological and environmental conditions that could be managed..." No evidence was found where this was analyzed. With so many actions being implemented, it might not be possible to track the effects of each individual project. However, the end results are often trend monitoring and are not directly linked to mitigation actions. The actual monitoring objectives of mitigation evaluation do not always neatly align with the monitoring approach.

Program Relevance and Project Results: The overall program is highly appropriate for the mitigation of fish and wildlife loses associated with the construction of Libby Dam. The proponents monitor specific actions, making adjustments in management strategies in response to monitoring results. Results and project summaries are reported in a timely manner.

Some of the work on fish community structure will be particularly relevant at other locations in the upper basin.

Results from the Kootenai nutrient fertilization project are summarized in at least three different reports. It is important that these results are synthesized in some way so the food web dynamics are analyzed in a comprehensive way with a comprehensive dissemination plan in place.

Broad Applicability: The overall program has broad applicability for situations where mitigation from dam construction is required.

Time Required: Depending on specific activities, some actions probably will be complete by 2015 (e.g., *Didymo*, if successful) and others (e.g., stream and fish restoration) will require several more years of monitoring and adjustments to techniques. Other projects (e.g., reservoir) are ongoing with no discernable end date.

Flathead

200600800	Mainstem Columbia Amendments Research at Libby Dam	Montana Fish, Wildlife and Parks (MFWP)
199101903	Hungry Horse Mitigation Habitat Restoration and Research, Monitoring and Evaluation (RM&E)	Montana Fish, Wildlife and Parks (MFWP)
199101901	Hungry Horse Mitigation/Flathead Lake Restoration and Research, Monitoring and Evaluation (RM&E)	Salish and Kootenai Confederated Tribes

200600800 - Mainstem Columbia Amendments Research at Libby Dam

Links to: project **and** reports

Proponent: Montana Fish, Wildlife and Parks (MFWP)

Province/subbasin: Mountain Columbia/Flathead

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What are the impacts of hydrosystem operations on mainstem habitats, including the freshwater tidal realm from Bonneville Dam to the salt wedge? How might hydrosystem operations be altered to recover mainstem habitats?
- Mainstem Hydrosystem Flow and Passage Operations: What are the optimal temperature and water quality regimes for fish survival in tributary and mainstem reaches affected by dams, and are there options for hydrosystem operations that would enable these optimal water quality characteristics to be achieved? What would be the effects of such changes in operations and environment on fish, shoreline and riparian habitat, and wildlife?
- Mainstem Hydrosystem Flow and Passage Operations: What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species

and stocks? What are the ecological effects of hydrosystem operations on downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?

Additional uncertainties addressed or raised (not in 2006 Research Plan):

- What is the relation between substrate aggradation at tributary deltas downstream of Libby Dam and spawning access by bull trout and other species?
- What are the range of potential causal mechanisms, operational and ecological, by which rainbow trout survival, growth, and condition can vary?
- How can *Didymo* be controlled?
- What are the factors affecting use of Montana's portion of the Kootenai River by white sturgeon?

Comment:

Mainstem Amendment operations limit summer drafting of Libby Reservoir and impose strict ramping rates on water discharged into the Kootenai River downstream of the dam. Mainstem Amendment operations are designed to benefit resident fish while still providing suitable flow conditions for anadromous fishes in the lower Columbia River Basin. The project uses a combination of model simulations and field validation data to quantify the effects of modified dam operations on physical and biological metrics in the river and reservoir systems. The annual report highlights results of the biological and physical monitoring through 2014. Biological and physical metrics evaluated include weighted usable area, inflow and outflow discharge patterns, water residence times, modeled primary and benthic productivity, fish condition, catch per unit effort of various fish species, population estimates and size structure indices, water temperatures, refill and draft rates, refill success, and survival of rainbow trout. Results of other monitoring and research efforts are also presented, including the seasonal dynamics of *Didymosphenia geminata* in the Kootenai River, quantifying juvenile to adult survival of bull trout, updating the status of Kootenai River white sturgeon in Montana, and identifying possible limiting factors of aquatic invertebrates and trout in the Kootenai River.

There is considerable overlap between this report and another annual report prepared by Montana Fish, Wildlife and Parks (MFWP; Project No. 1995-004-00). Perhaps these reports should be combined with a synthesis at the end?

Methods: Standard methods are used for all characteristics measured. Hypotheses are listed for each work element. Data management and the dissemination of information are not discussed.

Program Relevance and Project Results: While few biological benefits have been detected for resident fish in the Kootenai River and Libby Reservoir, recent changes to operations have not been detrimental to most biological and physical metrics being evaluated. Recent operations have created more normative, stable habitat conditions that are functionally and ecologically more similar to the pre-dam conditions of the Kootenai River downstream of Libby Dam and in general, maintained a fuller reservoir pool upstream of Libby Dam. The monitoring is comprehensive and informative, but it is not clear if, or how, it is used to modify management actions (adaptive management).

The findings raise a question about the usefulness of the existing LRMOD model which may point to a larger issue in the region concerning how thoroughly model output is evaluated. The report also questions the validity and usefulness of the IFIM model to assess the impact of dam operations on habitat area for bull trout. That is, the benefits expected due to model predicted increases in habitat area may not be realized if modified dam operation also changes other factors that influence fish abundance, condition, and productivity.

This project addresses numerous uncertainties not in the 2006 Research Plan: What is the relation between substrate aggradation at tributary deltas downstream of Libby Dam and spawning access by bull trout and other species? The study has thus far assessed the aggradation. The topographic maps are charted for several streams, but there has been no interpretation of the specific potential effects on spawning migration of bull trout and other species.

Because of a range of potential causal mechanisms, operational and ecological, by which rainbow trout survival, growth, and condition can vary, it is important moving forward that some causal mechanisms be identified.

An uncertainty that may have only local applicability is how to control *Didymo*. Another uncertainty, perhaps only of local impact, is the reason for the decline in bull trout redds in recent years.

What factors are responsible for the decline in bull trout redds over the last decade? (The proponents concluded that there was no evidence to support water temperature as a cause.)

It is not clear exactly how invertebrate sampling is expected to be analyzed so that meaningful inferences can be made regarding the role of operations on food webs. Analysis had not been completed at the time of the report.

An added uncertainty related to fish propagation is the role and situation of the hatchery sturgeon in the system. A critical uncertainty: what are the factors affecting use of Montana's portion of the Kootenai River by white sturgeon.

Broad Applicability: The program is comprehensive, offering a model for others investigating the effects of dam constructions and modifications to operating procedures.

The findings regarding tradeoffs of environmental operations vs. refill reliability vs. productivity impacts (as well as the lack of response of the fish) of the modified operations are interesting and should be more broadly disseminated (e.g., to CRITFC and other scientists).

There needs to be more coordination between the groups working on the Kootenai than is demonstrated in these reports.

Time Required: An additional 5-10 years, at least, will be needed to fully assess changes to dam operations on the reservoir and river biota. The authors point out that there were "forced and experimental spills" that might have impacted their ability to detect effects of the modified operations and thus need additional time without spill to sort out biological responses since the spills negatively impact the fish. The proponents indicated that because of operational variability, an additional 3-5 years of sampling will be needed to evaluate the impacts of operations on rainbow trout survival condition and size structure, as well as thermal conditions in the Kootenai River. It may take longer to identify causal mechanisms. Other projects (e.g., reservoir) are ongoing with no discernable end date. It will also take at least 5-10 years to assess sturgeon as they become adults.

199101903 - Hungry Horse Mitigation Habitat Restoration and Research, Monitoring and Evaluation (RM&E)

Links to: project **and** reports

Proponent: Montana Fish, Wildlife and Parks (MFWP)

Province/subbasin: Mountain Columbia/Flathead

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Fish Propagation: What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?
- Non-native and invasive species: To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Will it be possible to maintain genetically pure, self-sustainable resident populations of native trout and char (cutthroat trout, rainbow trout, redband trout, bull trout, etc.) in the face of naturalized populations of non-native trout, char, and other aquatic species; population fragmentation; habitat degradation; climate change; and other stressors?

Comment:

The most recent annual report was from January 2015. Information from the project may indirectly contribute to 2006 uncertainties related to (1) fish propagation and (2) non-native and invasive species if the information was included in larger syntheses.

This project focuses on improving conditions for native fish survival and recovery in the upper Flathead River and Lake system. Recent work focused on assessing population level effects of dam operations on native fishes (bull trout, Westslope cutthroat trout, and mountain whitefish), implementing habitat improvements and fish passage projects, and quantifying and mitigating deleterious effects of non-native aquatic species on native fishes.

Methods: Project goals and quantifiable objectives with timelines for achievements were not stated. However, this is a diverse mitigation project aimed at improving conditions for native fish survival and recovery in the upper Flathead River and lake system. The work focuses on assessing population level effects of dam operations on native fishes (i.e., bull trout, Westslope cutthroat trout, and mountain whitefish), implementing habitat improvement and fish passage projects, and quantifying and mitigating deleterious effects of non-native aquatic species on native fishes. There are six projects with multiple specific actions described in the report:

1. South Fork Flathead Drainage Westslope Cutthroat Trout (WCT) Conservation Program – sampling, data analysis, hybrid trout removal, and restocking of treated lakes;
2. Hybrid and Rainbow Trout Suppression in the Flathead River System – Westslope cutthroat trout and brook trout hybridization data collection and analysis, and removal and relocation of hybrids and rainbow trout from tributaries;
3. Developing Innovative Tools to Evaluate Conservation Efforts – genetic markers to assess connectivity and restoration of bull trout;
4. Monitoring Lake Trout Spawner Movement and Reproductive Success to Evaluate Suppression Strategies – Swan Lake trout assessment, use of electricity as a lake trout suppression tool, and genetic evaluation of lake trout suppression in Swan Lake;
5. Plantings and Weed Control – planting to protect property acquisitions supporting fish conservation; and
6. Native Fish Habitat Enhancement and Monitoring – South Fork Coal Creek enhancement design and implementation, bull trout spawning habitat monitoring and analysis, Young’s Creek Westslope cutthroat trout collections for Sekokini Springs rearing facility, and weed control at Sekokini Springs.

All methods seemed to be standard methods used by fisheries scientists and appear to be applied correctly. Montana Fish, Wildlife and Parks has done an excellent job in standardizing techniques and providing documentation. However, it is noted that estimates of trout abundance are presented without measures of precision.

Program Relevance and Project Results: This diverse program is highly relevant for restoring sustainable populations of native resident fishes, especially bull trout, Westslope cutthroat trout, and mountain whitefish. Monitoring data were collected at appropriate intervals and, in many cases, the data indicated positive trends. The proponents are professionally productive, regularly publishing articles in peer-reviewed journals. The overall program is a model of the integration of research, monitoring, and management applications for resident fishes. The general mitigation project has been in place since the early 1990s. The current program (including monitoring) has been in place for a little more than a decade but will require many more years to demonstrate either effectiveness of management activities or the need to curtail activities that are not successful.

Some of the most exciting findings are the development of genetic tools to evaluate conservation efforts. Over 5,000 loci have been identified which will enable rapid assessment and high power resolution of bull trout population structure, sex ratios, movement patterns, abundance of spawners, local adaption, and hybridization.

Broad Applicability: The information provided by this project has relevance to the restoration of bull trout, Westslope cutthroat trout, and mountain whitefish throughout their distributions in the Columbia River Basin.

Time Required: Large scale restorations efforts for native species such as bull trout and Westslope cutthroat trout are very long term.

199101901 - Hungry Horse Mitigation/Flathead Lake Restoration and Research, Monitoring and Evaluation (RM&E)

Links to: project **and** reports

Proponent: Salish and Kootenai Confederated Tribes

Province/subbasin: Mountain Columbia/Flathead

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Non-native and invasive species: What are the primary pathways of introduction of invasive and nonnative species, and what methods could limit new introductions or mitigate the effects of currently established invasives?

Additional uncertainty addressed or raised (not in 2006 Research Plan):

- Will it be possible to maintain genetically pure, self-sustainable resident populations of native trout and char (cutthroat trout, rainbow trout, redband trout, bull trout, etc.) in the face of naturalized populations of non-native trout, char, and other aquatic species; population fragmentation; habitat degradation; climate change; and other stressors?

Comment:

The most recent annual report was from August 2014. Information from the project might contribute indirectly to a single 2006 uncertainty related to non-native and invasive species if the information was included in a larger synthesis.

This report addressed a broad range of the factors limiting native fish distributions and abundances primarily within the Flathead Indian Reservation but also elsewhere within the Flathead Subbasin. A key focus area was Flathead Lake where the following activities were conducted: (1) creel surveys, (2) estimation of lake trout size structure, growth rate, mortality rate, and distribution, (3) estimation of lake trout population size by means of two separate mark and recapture population estimates, and (4) monitoring and analysis of rates of shoreline erosion.

Methods: Project goals and quantitative objectives were not stated in the report. The annual report addressed a broad range of management actions on the Flathead Indian Reservation. Creel surveys and tag-recapture methods were used to evaluate lake trout size distribution and abundance in Flathead Lake, but limited descriptions of these methods prevented judgments as to their soundness. No measures of precision were provided. Genetic techniques were used to evaluate introgression by rainbow trout on isolated Westslope cutthroat trout in reservation streams. Genetic analyses were conducted by researchers at the University of Montana and appeared to be of high quality. Engineering techniques were used to retard shoreline erosion. Land purchases were used to protect and restore streams.

Program Relevance and Project Results:
Monitoring data indicated no changes in lake trout abundance (2009-2013) associated with removal of lake trout through angling. Exploitation rates appeared to be insufficient to reduce lake trout abundance. No data were presented for other species of interest (e.g., bull trout). The relevance of the lake trout program for the recovery of bull trout is not apparent. Genetic introgression in Westslope cutthroat trout appears to be limited and the constructed fish barriers appeared to protect small, isolated populations. Shoreline erosion techniques seemed to be effective in the limited areas where they were implemented. The land purchases were small and isolated, and their overall effectiveness in protecting streams was questionable. The land was being restored toward natural conditions.

Broad Applicability: The lake trout program is interesting and enjoys broad public support. However, its applicability to lake restoration for native fishes is questionable. The information may be applicable to lakes and reservoirs in the Columbia River Basin where non-native lake trout have been introduced. The genetic studies of Westslope cutthroat trout have broad applicability to assess introgression in other isolated populations. The shoreline erosion actions and the land purchases do not appear to be part of a long term strategy and, therefore, do not have broad applicability. Overall, the project results are interesting but their applicability to meeting general goals is not apparent. Unless specific goals and quantifiable goals are established, the project may lack scientific justification for continuation.

Time Required: It is likely that the lake trout control efforts will never end.

Wildlife

200600600	Habitat Evaluation Project	Columbia Basin Fish and Wildlife Foundation
200800700	Upper Columbia United Tribes (UCUT) Monitoring and Evaluation (M&E) Program	Upper Columbia United Tribes (UCUT)
200201100	Kootenai River Operational Loss Assessment	Kootenai Tribe
200301200	Shillapoo Wildlife Mitigation	Washington Department of Fish and Wildlife (WDFW)
199802200	Pine Creek Conservation Area	Confederated Tribes of Warm Springs
200600300	Desert Wildlife Mitigation	WDFW
200600500	Asotin Creek Wildlife Mitigation	WDFW
199608000	Northeast Oregon Wildlife Project	Nez Perce Tribe
200000900	Logan Valley Wildlife Mitigation	Burns-Paiute Tribe
200002700	Malheur River Wildlife Mitigation	Burns-Paiute Tribe
200103300	Hangman Creek Fish & Wildlife Restoration	Coeur d'Alene Tribe
199206103	Albeni Falls Wildlife Mitigation-Idaho Department of Fish and Game (IDFG)	Idaho Department of Fish and Game (IDFG)

Wildlife Programmatic Comments

The idea of "uncertainties" for the wildlife projects is different than for fisheries projects, especially because of the listing of the salmon and steelhead.

Data collection: There is a long history of the ISRP recommending data collection for monitoring of wildlife projects. The Metrics Review (ISRP 2008-7) provided suggestions for metrics useful for data collection, as well as thoughts about monitoring effectiveness. In general, wildlife project types are Operation and Maintenance (O&M) or Monitoring and Evaluation (M&E). These two types are further differentiated because often wildlife projects are tied to legal settlements and some of these settlements include M&E, while some do not.

Regional wildlife M&E and HEP: The region has a history of inadequate monitoring and evaluation of wildlife projects, so it is difficult to identify uncertainties associated with management actions or with biological and social interactions. The region has used Habitat Evaluation Procedures (HEP) as a tool for data collection that was standardized across wildlife projects. The ISRP has urged participants to use HEP primarily as an accounting tool, not as a monitoring tool. The Wildlife Advisory Committee, composed of State and Tribal leaders has reviewed HEP with the result that HEP is being discontinued as a basinwide project; individual project proponents may continue to use HEP methodology for project specific purposes. A relatively recent wildlife project sponsored by the Upper Columbia United Tribes (UCUT) is unique because it includes M&E of O&M acquisition projects. The UCUT Project may be a useful model for future wildlife projects and could be helpful for understanding uncertainties. The ISRP urges the Council and proponents to rely on guidance for monitoring and evaluation of project actions from the ISRP to make progress in understanding uncertainties.

Wildlife response to restoration: In the larger picture, there is much uncertainty associated with the response of many species to wildlife projects. An evaluation of the spatial extent and magnitude of response by wildlife species to habitat acquisition and restoration projects would be valuable. Addressing this uncertainty would require greater acceptance of a research focus for wildlife M&E projects.

Priority of riparian restoration: Given the history of monitoring and evaluation efforts, we suggest that riparian habitat management, especially east of the Cascades, should be a priority item. From a habitat perspective, we suggest that riparian habitat management would benefit both wildlife and fisheries resources, especially in arid environments. There are scientific uncertainties associated with trade-offs between managing only riparian buffers versus managing adjacent upland habitat. The ISRP recognizes that the best approach for riparian restoration is to use a landscape approach; that is to manage both riparian and adjacent upland habitat. However, from an uncertainty perspective, there is less uncertainty associated with wildlife benefits when riparian habitat is protected and managed. Riparian habitat management is also a proactive strategy given that western water issues will be affected by current drought conditions and longer term changes in climate. There are additional uncertainties and trade-offs associated with traditional human interactions and livelihoods (e.g., grazing, gathering activities) on project lands.

Large versus small acquisitions – demonstration projects: Uncertainties are associated with immediate acquisition of available sites versus waiting to acquire larger, more connected sites. Often acquisition of small sites has been justified as serving as demonstration sites. From a social science perspective, the uncertainty of demonstration projects should be considered. That is, small sites may have great social value. Identification or development of research that can help guide evaluation of social values and benefits of small projects is needed. Another uncertainty would be if small areas in landscapes, which are dominated by human interferences, assume large biological value. In systems with a large amount of human interference, there is uncertainty about whether the ecological or social perspective should be prioritized. Discussions of the ecological versus social value could be useful along with development of prioritization lists for restoration activities and locations. There is also uncertainty concerning prioritization of acquisition of new sites versus restoration of previously acquired sites.

Future wildlife project reviews: We understand that the Council is planning for the next categorical review of wildlife projects. We hope our comments on annual reports can aid in development of this process. When we undertook this annual report review, one of our goals was to determine if annual reports could serve as the primary project documents for an ISRP review. However, we found that the content and quality of many current annual reviews are not adequate to provide a basis for scientific project reviews. To increase the usefulness of wildlife projects' annual reports, they should include a description of methods used, lessons learned from application of those methods, and a summary of the results of the project, including links to where results have been reported. In addition, current management plans must be completed to complement annual reports. These up-to-date management plans should be standardized, informative, and include information on how the project is expected to benefit wildlife and how the benefits will be monitored. In summary, the wildlife review should include evaluations based on site visits, presentations, and written documents including management plans and annual reports for continuing projects.

Notes for Project Proponents

Ecosystem services: A recent paper (Griffiths et al. Journal of Applied Ecology 2014, 51, 1554–1563) may be an especially valuable perspective regarding techniques for evaluating anthropogenic influences on ecosystems.

1) The authors used sites with little anthropogenic influence as "control" sites and then use these sites to provide a bench mark on responses.
2) They incorporate variability in the response variable as an index of ecosystem services. This was via something called the Sharpe Ratio, the ratio of the response (their example was the number of returning salmon) over the variability of the response, described as risk.
3) Adopting the ecosystem services approach as described in the Griffiths et al. paper for wildlife projects, a response variable could be the estimated number of focal species -- such as birds, small mammals, or amphibians -- in the area.
4) We do know that climate change increases variability in systems, but there are many different perspectives regarding variability in responses.

Occupancy models: On a completely different front, the use of occupancy modeling along with careful use of covariates could be an especially valuable approach to M&E. Occupancy modeling uses less intensive monitoring (occupancy uses presence/absence vs. other methods used to calculate density from transects). Photo points might be an easy way to gather information about covariates on project sites. Thinking about this from an M&E perspective, projects change their management actions regularly, so some form of easily applied evaluation could be very valuable. The idea of using focal species or indicator species could also be useful.

200600600 - Habitat Evaluation Project

Links to: project **and** reports

Proponent: Columbia Basin Fish and Wildlife Foundation

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Monitoring and Evaluation (adaptive management): Can a common probabilistic (statistical) site selection procedure for population and habitat status and trend monitoring be developed cooperatively?
- Monitoring and Evaluation (adaptive management): Can a scientifically credible trend monitoring procedure based on remote sensing, photography, and data layers in a GIS format be developed?
- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?
- Monitoring and Evaluation (adaptive management): Make best professional judgment, based on available data, as to whether any new research in the spirit of the Intensive Watershed Monitoring approach should be instigated immediately. Most new intensive research should arise as a result of the interaction of existing inventory data with new data arising in population and habitat status and trend monitoring.

Comment:

This project did not directly address uncertainties, and this basinwide HEP project is being discontinued, but individual project proponents may continue to use the HEP methodology for project specific purposes.

Methods: The most recent progress report details monthly activities and changes in project management.

Program Relevance and Project Results: The ISRP has always considered HEP an accounting tool, without concomitant monitoring of wildlife species. The HEP team measured habitat values through vegetation well, and thus the projects reported good data on vegetation. A less intensive vegetation survey may be useful to compare to past HEP measurements, but this incurs high costs for monitoring teams to visit the area. HEP data can be used to ground truth remote sensing data. In addition, data from this project could provide vegetation metrics useful for assessing climate change.

Broad Applicability: The HEP work could possibly be linked (via regression) to indices of abundance of wildlife species, if those data are available. In the monthly reports, the proponents identify that they made data available to interested parties.

200800700 - Upper Columbia United Tribes (UCUT) Monitoring and Evaluation (M&E) Program

Links to: project **and** reports

Proponent: Upper Columbia United Tribes (UCUT)

Province/subbasin: Intermountain

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Climate Change: Can indices of climate change be used to better understand and predict interannual and interdecadal changes in production, abundance, diversity, and distribution of Columbia Basin fish and wildlife?
- Climate Change: What long-term changes are predicted in the Columbia River Basin and the northeast Pacific Ocean, how will they affect the fish and wildlife in the region, and what actions can ameliorate increased water temperatures, decreased summer river flows, and other ecosystem changes?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Monitoring and Evaluation (adaptive management): Can a common probabilistic (statistical) site selection procedure for population and habitat status and trend monitoring be developed cooperatively?
- Monitoring and Evaluation (adaptive management): Can a scientifically credible trend monitoring procedure based on remote sensing, photography, and data layers in a GIS format be developed?
- Monitoring and Evaluation (adaptive management): Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?
- Population Structure and Diversity: What approaches to population recovery and habitat restoration are most effective in regaining meta-population structure and diversity that will increase viability of fish and wildlife in the Columbia River Basin?

Comment:

This project does not directly address uncertainties. Data from this monitoring and evaluation effort could be valuable for investigating many climate change and habitat issues. Especially uncertainties associated with responses at “restoration” and “reference” sites for evaluating approaches to habitat restoration that are most effective in increasing viability of fish and wildlife. The project is also relevant to addressing uncertainties related to Monitoring and Evaluation in support of adaptive management and to uncertainties associated with Population Structure and Diversity.

This report is exemplary in its concise, yet complete overview of project accomplishments.

Methods: The purpose of the project is to develop and demonstrate methods for monitoring vegetation, small mammals, breeding birds, and amphibians and to illustrate how monitoring data can be used to evaluate change due to restoration management. The proponents have used statistical design (i.e. comparison of reference sites and mitigations sites) and sharing data and resources among projects as a unique approach for monitoring and evaluation among projects. They are monitoring and evaluating vegetation, small mammals, breeding birds, and amphibians.

Program Relevance and Project Results: Initial monitoring work was begun in 2002, and the proponents have visited 25 reference and 51 mitigation sites. The proponents present an interesting analysis of their preliminary data on (a) comparison of similarity across taxa (p. 12-13 of the progress report) for data collected in 2002 and 2006 and (b) comparison of mitigation with reference sites in shrub steppe habitat sampled between 2009 and 2012. They report (a) general lack of similarity across taxa and that (b) mitigation sites exhibit greater variation than reference sites and are distant in multivariate space from reference sites. Additionally, data are stored in a database (p. 16) available from the Kalispel Natural Resource Department, and the authors have presented their results to several audiences (p. 16-17).

Broad Applicability: There is broad applicability because this may be a valuable approach for others in the Columbia River Basin. Specifically, the project has applicability for a broad range of managers who need information about vegetative and vertebrate species that presently occur on their projects and to provide managers with information about the effectiveness of their habitat management.

Time Required: The most recent report (5/2014) presents preliminary results of data collected through 2011. In a past review, the ISRP recommended a second 5-year rotation and then resampling of the reference sites. Depending on results and application, this could be a long-term monitoring approach for wildlife projects.

200201100 - Kootenai River Operational Loss Assessment

Links to: project **and** reports

Proponent: Kootenai Tribe

Province/subbasin: Mountain Columbia/Kootenai

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Monitoring and Evaluation (adaptive management): Can a scientifically credible trend monitoring procedure based on remote sensing, photography, and data layers in a GIS format be developed?

Comment:

The project does not directly address any of the 2006 Research Plan uncertainties, but the project will generate data and analyses that could help inform the uncertainties.

The ISRP has participated in an iterative review of this project. The most recent ISRP review was in 2013: Meets Scientific Review Criteria (Qualified) – "The qualifications are that the ISRP would like to review the multi-year restoration plan, including specific goals and 5-10 year, quantitative objectives for their actions. The ISRP would also like to see documentation of progress at regular intervals of 1-2 years. Development of this plan is presumably the next step in the process after completion of the loss assessment. The sponsors have effectively mobilized experts from several disciplines and may already have annual reviews, so a restoration plan with quantitative goals and objectives and regular updates should be manageable" (ISRP 2013-13). A follow-up review is anticipated in 2016.

Methods: The report provides a series of ecological evaluations of a post-impoundment, large river-floodplain ecosystem, the Kootenai River system "to determine and quantify floodplain ecosystem function losses due to operation of Libby Dam." Additionally it is stated, "the overarching objectives of this project are to assess abiotic and biotic factors (i.e., geomorphological, hydrological, aquatic and riparian/floodplain communities) in determining a definitive composition of the Index of Ecological Integrity (IEI), producing a hydrologic predictive model and disseminate an operational loss assessment toolbox."

There is also a work item in the 2014 report, D. 156. Develop RM&E Methods and Designs which states that a new methodology was developed to calculate a floodplain Index of Fluvial Alteration (IFA) for this project. It is stated in the project statement that "overarching objectives of this project apply a structured (IFA) to quantify the impact of dam operation on the floodplain." In the 2013 report there is a work item C:156. Develop RM&E Methods and Designs-RDRT refine Indices of Ecological Integrity (IEI), which was completed.

It appears that there are a series of assessment/monitoring tools that are being developed and tested for use on the Kootenai project and potentially on other sites having fish and wildlife losses tied to the development and operation of hydro facilities. Methods for development of the models and some evaluation of their application are provided. It is also noted in the 2014 Report that the development team "revisited the indices that make up the IEI (Index of Ecological Integrity). Precision estimates were calculated for the IHA (Index of Hydrologic Alteration) and terrestrial IBI's (Index of Biological Integrity). Additionally, a sensitivity analysis was conducted on the terrestrial IBI's."

Program Relevance and Project Results: Development of a series of indices that can be used to assess a range of ecological (physical and biological) impacts/conditions in areas affected by construction and operation of hydro facilities, on Columbia Basin tributaries, is useful for program work on the Kootenai River. Procedures are being tested on the Flathead River and results look promising for the utility of these assessment tools on other river systems. It remains to be seen whether these tools will be a useful tool for tracking trends in biological and physical conditions in areas receiving protection, restoration, and mitigation treatments.

Broad Applicability: It is noted in one of the annual reports that there is a need to establish a regionally accepted framework for operational loss assessments and for the fish and wildlife managers in the Columbia River Basin to come to agreement on operational loss methodologies unlike crediting and ledger issues that hamper regional consensus. Additionally it is stated that one of the objectives of this project is to "initiate the development of a framework for a regionally applicable operational loss assessment for the Columbia River Basin." It is reported in the 2014 report that "The IHA approach used herein was effective for the Flathead River. This was particularly true at the resolution of the Operational Loss Assessment, which averages trends across many years within each scenario, and along fairly long river reaches, before comparison to other scenarios. Additionally, this method was effective on the Flathead River due to the reasonably abundant river flow data." It is also reported that work is underway to calculate an Index of Fluvial Floodplain Alteration (IFFA) for the Flathead River in northwestern Montana and that IFFA scores are being calculated and "once the results are finalized, the Flathead River IFFA analysis will be summarized in a report documenting the methods and results."

Time Required: There appears to be clear progress in the development and application of the loss assessment indices for the Kootenai and initial testing on other river systems. It remains unclear whether evaluation of the utility of application, of these tools, for tracking changes in conditions related to protection, restoration, and mitigation activities will be available in a 3-5 year time frame. It seems unlikely that this will occur.

200301200 - Shillapoo Wildlife Mitigation

Links to: project **and** reports

Proponent: Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Lower Columbia/Columbia Lower

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Monitoring and Evaluation (adaptive management): Can a scientifically credible trend monitoring procedure based on remote sensing, photography, and data layers in a GIS format be developed?

Comment:

This project does not directly address any of the uncertainty issues in the 2006 Research Plan, but monitoring data may be useful in support for addressing uncertainties.

Program Relevance and Project Results: In the report uploaded Feb. 2015 the proponents present a thorough annual summary for the time period Oct. 2012-Oct. 2013. They summarize work on wetland management, goose forage, tree and shrub plantings, invasive species management, as well as infrastructure maintenance and improvement. They use tables to display data and figures of photo plots well, and present some trend information on purple loosestrife that other land managers may find useful.

Broad Applicability: This could serve as an example of what, and how, to summarize annual activities.

Time Required: This is an ongoing wildlife mitigation project.

199802200 - Pine Creek Conservation Area

Links to: project and reports

Proponent: Confederated Tribes of Warm Springs

Province/subbasin: Columbia Plateau/John Day

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Climate Change: Can integrated ecological monitoring be used to determine how climate change simultaneously affects fish and wildlife and the freshwater, estuarine, ocean, and terrestrial habitats and ecosystems that sustain them?
- Monitoring and Evaluation (adaptive management): Can a common probabilistic (statistical) site selection procedure for population and habitat status and trend monitoring be developed cooperatively?
- Monitoring and Evaluation (adaptive management): Can a scientifically credible trend monitoring procedure based on remote sensing, photography, and data layers in a GIS format be developed?

Comment:

This project can indirectly aid work on uncertainties. The proponents are contributing information to address these uncertainties. For instance, they have estimates of vegetation community changes (natural resource re-inventories) that could be useful to inform climate and management uncertainties. See Work Element N as an example.

Program Relevance and Project Results: FY2011-12 Report submitted in March 2015. The report summarized progress by work elements (Work Elements) and gave a detailed summary of cattle trespass problems (see this Work Element for details, p. 6) and work to resolve these.

Broad Applicability: Other projects may find the results of this study useful. This project was geared to comprehensively re-examine all facets of the vegetation on the property, following an initial inventory and base mapping which was conducted in 2002. The study produced a brief synopsis report accompanied by five detailed attachment reports addressing each of the discreet study products: new base mapping; juniper change; estimation of change for sagebrush/shrubs; vegetation composition; and cultural plant modeling (2013 Pine Creek Conservation Area Mapping and Monitoring Report, Institute for Natural Resources, Portland State University. Including attachments and appendices). Additionally, the type of information that authors have collected may be valuable. “In general, photo comparisons of 28 sample points, utilizing shots from 2000-2001 versus 2012, show a trend of increased height and width of riparian vegetation on the Pine Creek main stem with a slower improvement in the tributary drainages” (p.10).

Time Required: Their goal is to summarize trends in 5 year increments.

200600300 - Desert Wildlife Mitigation

Links to: project **and** reports

Proponent: Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Columbia Plateau/Crab

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Monitoring and Evaluation (adaptive management): Can a scientifically credible trend monitoring procedure based on remote sensing, photography, and data layers in a GIS format be developed?

Comment:

This project does not address any of the 2006 Research Plan uncertainties directly. Data collected can indirectly contribute to addressing the three uncertainties listed above.

These project areas are wetland basins adjacent to irrigation wasteways. Rotenone and physical barriers are used to control fish in some basins. Wetlands are manipulated in an effort to maintain sites in early vegetation seral stages. There is some monitoring done to detect change and identify problems that may impact wetland enhancement.

On August 14, 2015, the ISRP completed a review of this project's progress report document *Desert Wildlife Area O&M (Wetland Enhancement) 14-year Final Monitoring Report (2002-2015)* (ISRP 2015-8).

The ISRP appreciated the concise 14-year monitoring report and the attempt to address previous comments by the ISRP. Although the monitoring report contained useful data and findings about the restoration effort, the ISRP requested that the proponents provide more details on:

1. Goals and objectives (How do the goals and objectives differ between the two project areas [TD1, TD2] and why were the goals selected for each of these?);
2. Methods, including vegetation sampling, wetland boundary delineation, and waterfowl surveys;
3. Wetland restoration and management actions, including water management; and
4. Results, specifically for any statistical analyses completed.

The ISRP requested that a revised progress report be submitted as part of the Fish and Wildlife Program's upcoming Wildlife Category Review (or sooner if the Council requests).

200600500 - Asotin Creek Wildlife Mitigation

Links to: project **and** reports

Proponent: Washington Department of Fish and Wildlife (WDFW)

Province/subbasin: Blue Mountain/Asotin

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Monitoring and Evaluation (adaptive management): Can a scientifically credible trend monitoring procedure based on remote sensing, photography, and data layers in a GIS format be developed?

Comment:

No 2006 Research Plan uncertainties are directly assessed, but information from this project could inform uncertainties associated with the effectiveness of habitat restoration and non-native weed management. Data on vegetation from Smoothing Iron parcel (part of Schlee Ranch) are collected by the Regional HEP team. It is uncertain how vegetation data will be obtained in the future given the future status of HEP.

199608000 - Northeast Oregon Wildlife Project

Links to: project **and** reports

Proponent: Nez Perce Tribe

Province/subbasin: Blue Mountain/Grande Ronde

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Climate Change: What long-term changes are predicted in the Columbia River Basin and the northeast Pacific Ocean, how will they affect the fish and wildlife in the region, and what actions can ameliorate increased water temperatures, decreased summer river flows, and other ecosystem changes?

- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

Comment:

The project is not directly addressing any of the 2006 Research Plan uncertainties. Information gained from the project, however, could be used to address the uncertainties shown above. The project area has extensive cattle use, and M&E on grazing and wildlife impacts could be used to inform uncertainties on cattle grazing management in conservation areas.

Methods: HEP and HU accounting.

Program Relevance and Project Results: Document P140101 uploaded Oct. 2014 is a report from Dec. 2003 that describes the project. Precious lands acquisition (16,000 ac). Baseline HEP in 2001, 2002.

Broad Applicability: A discussion on how HEP was used to identify limiting factors (ala Uncertainty, p. 29 of the progress report) is presented. Because of the size of the area protected/managed, this may impact water temperatures and allow assessment of landscape management and climate change, but this is far from the project's original intent.

Time Required: This ongoing wildlife property O&M project may have information valuable for use in other uncertainty investigations in 3-5 years.

200000900 - Logan Valley Wildlife Mitigation

Links to: project **and** reports

Proponent: Burns-Paiute Tribe

Province/subbasin: Middle Snake/Malheur

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Climate Change: Can integrated ecological monitoring be used to determine how climate change simultaneously affects fish and wildlife and the freshwater, estuarine, ocean, and terrestrial habitats and ecosystems that sustain them?
- Climate Change: What long-term changes are predicted in the Columbia River Basin and the northeast Pacific Ocean, how will they affect the fish and wildlife in the region, and what actions can ameliorate increased water temperatures, decreased summer river flows, and other ecosystem changes?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?

- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Human Development: How might the projected changes under different development scenarios affect land use patterns, protection and restoration efforts, habitats, and fish and wildlife populations?

Comment:

Project data could potentially be used to help resolve these uncertainties, for example, treatment areas, bird and vegetation surveys, and streamside vegetation photos.

The ISRP agrees that linking this work to the fish monitoring (BPT's FY2014 Annual Report for BPA Project# 1997-019-00 – Evaluate the Life History of Native Salmonids in the Malheur Subbasin) also occurring on the area is a good idea and suggests that an inclusion of a brief summary of information from that project would be useful here.

Methods: The proponents uploaded 2014 bird survey data into Interactive Habitat and Biodiversity Information System for the Columbia Basin (IBIS). Standard activities of planting willow, fencing and weed control were used. The proponents' first efforts at re-establishing willows were in 2014. The proponents continue to work on control of reed canary grass. The proponents participate in the Conservation Reserve Enhancement Program (CREP) and are in their sixth growing season.

Program Relevance and Project Results: Project level monitoring of plant establishment, bird surveys, and before and after stream photos were reported. Fisheries research is conducted by Project# 199701900 so results are not included in this annual report.

Broad Applicability: Primarily local impact. Results are site specific, although Appendix C re: Oregon Semaphore grass history may be useful to others. Logan Valley was identified (1986) by the Oregon Natural Heritage Program as one of the best examples of mountain meadows in the Blue Mountain Ecoregion

Time Required: The need for wildlife habitat protection is ongoing.

200002700 - Malheur River Wildlife Mitigation

Links to: project **and** reports

Proponent: Burns-Paiute Tribe

Province/subbasin: Middle Snake/Malheur

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Climate Change: What long-term changes are predicted in the Columbia River Basin and the northeast Pacific Ocean, how will they affect the fish and wildlife in the region, and what actions can ameliorate increased water temperatures, decreased summer river flows, and other ecosystem changes?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?
- Habitat: To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?
- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Human Development: How might the projected changes under different development scenarios affect land use patterns, protection and restoration efforts, habitats, and fish and wildlife populations?

Comment:

This project is indirectly addressing the above uncertainties as information from the project could be used to help answer these uncertainties. The project includes sage grouse lek counts and other bird surveys. This is a useful approach, and the ISRP was pleased to see that sage grouse lek monitoring included visiting historical lek sites that have a recent history of no use; these lek surveys could be especially valuable if populations in an area increase (e.g. Roy Reservoir). This project also includes streamside photo records that could be useful in helping understand climate change. Of particular interest to sage grouse management and more generally to recovering threatened species are the proponent's surveys of abandoned and re-used leks. Evaluation of the use of abandoned and re-used leks could address uncertainties for threatened bird species.

Program Relevance and Project Results: The 2014 Annual report reports summary of activities and wildlife survey information. The proponents present an assessment of unique control efforts directed at Rush Skeletonweed. Several state listed rare wetland bird species (sandhill crane, black necked stilt, curve-billed curlew) were observed, and sage grouse lek count data were summarized. Additionally, bat surveys identified State-listed species in the area. Redband trout exist on the property. The conclusion is that property has high wildlife value.

Broad Applicability: Evaluation of the use of abandoned and re-used leks could inform other projects.

Time Required: May have valuable information in 3-5 years.

200103300 - Hangman Creek Fish & Wildlife Restoration

Links to: project **and** reports

Proponent: Coeur d'Alene Tribe

Province/subbasin: Intermountain/Coeur d'Alene

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Habitat: What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?
- Habitat: Are the current procedures being used to identify limiting habitat factors accurate?

Comment:

This project indirectly addresses the uncertainties shown above. Project activities result in data, however, that can be useful in addressing these uncertainties.

Methods: This work is a comparison of HEP information collected in 2005 and 2010. 2010 work was done by the Regional HEP team. HEP values increased about 15% between survey periods. The proponents identified survey transect locations; others may find these transect locations useful.

Broad Applicability: None, site specific.

199206103 - Albeni Falls Wildlife Mitigation-Idaho Department of Fish and Game (IDFG)

Links to: project **and** reports

Proponent: Idaho Department of Fish and Game (IDFG)

Province/subbasin: Intermountain/Pend Oreille

2006 Research Plan uncertainties addressed:

Indirect or Potential:

- Human Development: How might the projected changes under different development scenarios affect land use patterns, protection and restoration efforts, habitats, and fish and wildlife populations?

Comment:

This project does not directly address any of 2006 Research Plan uncertainties. The uncertainty on human development is one that this project should consider, especially in prioritization of acquisitions. With treatment and control comparison sites this project could provide information on this uncertainty.

The authors reported preliminary analysis of reed canary grass control, and we have summarized their results here because there is much interest in reed canary grass control. The authors conducted a literature review (identified in 2014 annual report, Appendix B) of reed canary grass control efforts. The authors identify “A monitoring study to look at how a competitive seeding can control reed canarygrass could be started with the start of the Clark Fork River Delta Restoration Project.” A couple tentative results were presented in this annual report. For instance, “The Lower St. Joe property is dominated by reed canarygrass which has very low wildlife values. As part of the wetland restoration plans for this site, the IDFG completed multiple applications of both mechanical and chemical control to remove the reed canarygrass. Following these practices, the site will be seeded to a mix of grass/sedge species.” On the Pack River Delta Restoration Project, the authors present some data (p. 48 of the progress report) and tabulations that suggests that sod stored during island construction and re-distributed after construction resulted in higher reed canary abundance than on bare soil sites. On p. 72-72, the authors present a summary of observations from on-the-ground management attempts to control reed canary grass.

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