Independent Scientific Review Panel
for the Northwest Power and Conservation Council
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Presentation

ISRP Retrospective Report 2011

ISRP members Rich Alldredge (Chair), Tom Poe, Pete Bisson, Greg Ruggerone, and Eric Loudenslager (on the phone) will present findings and answer questions regarding the ISRP's Retrospective Report 2011 (ISRP 2011-25).

Executive Summary

This 2011 Retrospective Report expands upon the review of results that the ISRP conducted as part of its programmatic and individual review of projects in the Research, Monitoring, Evaluation, and Artificial Production Category Review (RMEAP Category Review Report; ISRP 2010-44). As requested by the Northwest Power and Conservation Council, this report summarizes accomplishments of approximately 150 Fish and Wildlife Program projects and the status of major basinwide programmatic issues in three key areas: 1) artificial production, 2) passage through mainstem dams, the river, and reservoirs, and 3) habitat restoration monitoring. The ISRP undertook this effort in response to the Council's desire to increase the visibility of project and program results. The ISRP did not summarize accomplishments of projects or topics for which synthesis reports are anticipated in 2012, such as ocean and estuary projects, the Integrated Status and Effectiveness Monitoring Project (ISEMP), and sturgeon projects.

The ISRP found that monitoring and evaluation has improved in all three major areas covered by this report. Nonetheless, lack of a comprehensive analysis of biological objective achievements for hatchery and habitat efforts impedes the understanding of program effectiveness. The Basin would benefit from an evaluation of management strategies and a structured decision approach for these categories, an approach that combines habitat, hatchery, passage, and full life-stage recruitment information. Although hatchery production has contributed to more adult fish, and in recent years harvest opportunities have increased, with some exceptions, supplementation experiments generally have not demonstrated improvement in the abundance of natural-origin salmon and steelhead. In addition, major biological improvements have not been measured as a result of habitat restoration. Although

passage issues may seem largely addressed, several topic areas remain of concern, including contaminants, altered life histories (e.g., mini-jacks), and competition and predation from non-native species.

For the three main areas of focus, the ISRP provides the following summary of conclusions and recommendations.

Artificial Production

An analysis of abundance and productivity is urgently required for projects in the supplemented locations, especially for those tributaries where there is a conservation objective in the management plan. Based on findings listed below, the ISRP concludes that there is an absence of empirical evidence from the ongoing projects to assign a conservation benefit to supplementation other than preventing extinction. The supplementation projects with high proportions of hatchery fish in the hatchery broodstock and on the natural spawning grounds are likely compromising the long-term viability of the wild populations. Evaluation of most supplementation projects would benefit from a more thorough comparison with life-stage specific productivity and recruitment of salmon from un-supplemented reference streams. All programs should evaluate the potential influence of density-dependent effects. In programs where density-dependence has been detected at lower adult population levels than previously estimated, there is a need for further research into the causes of this situation. In other words, there is a need to better understand the limitations on capacity of spawning and rearing habitat and whether such limitations are restricting the production of smolts when additional adults reach the spawning grounds, even though total spawner abundance is currently low relative to historical conditions.

Although managers using hatchery supplementation seem to be aware of ongoing habitat restoration efforts, there is a need to better integrate supplementation with habitat restoration because rebuilding natural populations will ultimately depend on improving habitat quality and quantity. Recruits per spawner ratios must exceed 1 on a consistent basis in naturally-spawning stocks to achieve the ultimate goal of self-sustaining wild populations. Until this happens, supplementation is only a life support system. In supplemented streams where density dependence constrains natural abundance, supplementation may enhance genetic risks for loss of natural spawning fitness without any attendant benefit.

A Before-After Control-Impact (BACI) design was used to evaluate spring Chinook supplementation in the Imnaha River, Oregon (summarized in the Lower Snake River Compensation Plan Review; ISRP 2011-14), and steelhead supplementation in the Umatilla River, Oregon, but not in other programs. The ISRP recommends that this method, or alternatives of similar statistical validity, be used at all locations that have programs where the intention is that returning hatchery fish will spawn in the streams.

The BACI analysis of Imnaha spring Chinook (reported in ISRP 2011-14) indicated that abundance of Imnaha River fish decreased post supplementation relative to five reference sites and increased relative to four reference sites. The analysis found that spring Chinook productivity in the Imnaha River had decreased relative to all nine unsupplemented sites. In Umatilla River steelhead, BACI analysis using John Day River steelhead populations as a reference location demonstrated an increase in natural-origin adult steelhead abundance without a decrease in productivity. However, in a separate analysis, larger numbers of Umatilla steelhead spawners were associated with reduced numbers of smolts per spawner, reduced length at age, and increasing smolt age, suggesting that habitat conditions in the watershed constrained population growth. Quantification of supplementation effects on abundance and productivity needs to be evaluated at the other locations to establish the range of benefits and losses.

For steelhead, spring Chinook, and fall Chinook, the numbers of smolts per spawner often declined in response to larger numbers of parent spawners. Density-dependent survival in these watersheds appeared to be restricting the increase in smolt production that was expected from increased spawner abundance in the streams. Length-at-age decreased and average age of steelhead smolts increased with greater spawning abundance in the Umatilla watershed, suggesting that density dependence in this watershed was related in part to the food web.

Most, but not all, of the hatchery programs were self-sustaining. At least one adult female returned to the hatchery or tributary weir from the spawning of one adult female in the hatchery. On this basis, the program might maintain an important genetic lineage that otherwise would be lost. Over the long term, however, hatchery-dominated programs implemented to reduce extinction risk will result in genetic changes due to domestication selection. These adverse effects have the potential to offset demographic benefits to natural origin fish.

Fish and Wildlife Program projects using parentage analysis often demonstrated that the relative reproductive success of hatchery-origin adults was less than natural-origin adult salmon and steelhead. The range and variation in relative reproductive success among species and systems was substantial and warrants case-by-case consideration in management decisions. Steelhead from hatchery programs using non-local stocks typically exhibited very small relative reproductive success when contrasted with local natural-origin steelhead. Local stocks of steelhead used in supplementation programs exhibit a range of relative reproductive success; there is evidence for a substantial genetic contribution to the reduced relative reproductive success and also evidence this carries over to naturally produced progeny of hatchery-origin parents. The implication of this observation is that deleterious genetic effects from the hatchery may depress the productivity of the natural population. In spring Chinook salmon, local stocks used in supplementation exhibited relative reproductive success ranging from greater than 90% of natural fish to approximately 50% of natural fish. However, in regard to the case of the 50% success rate, when spawning location was included as a covariate, there was no difference in female reproductive success.

The ISRP recommends a review and summary of post-release performance differences be conducted among the hatcheries or within years in a hatchery for a number of the fish culture practices such as acclimation versus direct release, on-site versus satellite facility release, rearing densities, and size and timing at release. This summary could contribute to explaining differences in the performance of smolts after release and inform modifications in hatchery operations.

Kelt reconditioning as a recovery tool is in an early stage of development. Successful reconditioning to increase survival and subsequent reproduction may not provide benefits for recovery; evaluations of the demographic effects of kelt reconditioning on viability assessments at the population and evolutionary significant unit (ESU) are necessary. The scale of implementation required for contributing to recovery and delisting must be estimated before assessment about the potential for success of kelt reconditioning as a recovery tool can be made.

The sockeye captive brood project has successfully prevented extirpation of the Red Fish Lake sockeye population. However, substantial improvements in survival are still needed before a natural population could be viable. The program needs to continue and expand monitoring of survival during each life stage of natural sockeye and identify areas of focus that are likely to enhance viability of the sockeye population. A comprehensive synthesis and assessment of the sockeye rebuilding effort would be worthwhile as a means to identify specific metrics and activities needed to achieve a viable natural population.

Mainstem Hydrosystem Passage and Related Life History Monitoring and Research

The ISRP considered four categories of projects related to passage: 1) development and installation of new monitoring systems plus data storage and management, 2) hydrosystem core RME projects, 3) training and data analysis support projects, and 4) life history, fish population status, and hydrosystem/hatchery uncertainties.

In the review, the ISRP found that the projects answered most of the Council's questions regarding major program management issues and associated high level indicators (HLI's). In addition, the ISRP did not find excessive overlap of objectives, data gaps, or duplication of data collection among this group of projects.

The ISRP concluded that projects providing important monitoring tools, data storage, and support services for listed salmonids and other stocks and species in the Columbia River Basin are essential, and there is a continuing need for further development, testing, and evaluation of Passive Integrated Transponder (PIT) tag technologies and data storage and retrieval systems. The ISRP concluded that the successful development of spillway PIT tag detection systems for mainstem dams is a high priority and recommended additional effort to evaluate the biological aspects of PIT tagging such as tag loss and tag-related mortality.

Projects that include coordinating and mobilizing data sets for management applications are of great benefit. The projects providing real time series of juvenile passage data to support a decision framework for hydrosystem operations to benefit fish passage, providing information on how survival of migrating juvenile salmonids is affected by operation of the Federal Columbia River Power System (FCRPS), and providing long-term data series of the smolt-to-adult portion of the life cycle to address management questions are all beneficial. One project that is designed to empirically test the hypothesis that smolts that pass through Snake River dams experience delayed or extra mortality has potential to provide answers to some of key questions and should be continued.

Of particular value in this group of projects categorized as mainstem projects were the Snake River wild fall Chinook research and early life history studies. The analyses of abundance and growth data with stock recruitment relationships to address density dependence in supplementation programs were revealing. Post supplementation, there has been a significant decrease in smolt size. Hatchery supplementation has been associated with large increases in redd counts, followed by a leveling off/slight decline of natural fish. There are some indications that density dependent factors might have an effect as stock size rebuilds. Whether or not density-dependence or other hatchery-wild interactions are occurring may be a contentious issue, but regardless of the outcome, addressing these questions with their long-term data sets is a highly important use of the data, and an appropriate approach for evaluating and shaping other supplementation projects in the Basin.

The development of the hydrosystem has altered predator prey interactions. A considerable amount of useful work on individual predator species has taken place. Perhaps it should now be asked what specific salmonid stocks are most vulnerable to various predators in an attempt to sort out potential population effects. Some large-scale life-cycle modeling seems in order that includes mortality from all predators as a group. The importance of predators on smolt-to-adult ratios (SARs) is a continuing issue that needs attention.

Habitat Restoration Monitoring

Progress has been made in the standardization of effectiveness evaluation in habitat restoration. While the ISRP applauds overall attempts to bring greater consistency to habitat restoration effectiveness monitoring, we caution against attempting to apply a “one-size-fits-all” habitat monitoring and evaluation approach to every situation. Advances in physical and chemical measurement and analytical technology will render some approaches to monitoring obsolete over time, and any monitoring protocols must be open to new, more efficient techniques. Unusual circumstances such as natural disturbances (fires, floods, etc.) and some types of anthropogenic impacts, such as chemical use, may provide opportunities to apply nonstandard monitoring tools and altered sampling schemes to maximize learning opportunities. Finally, there is a risk that strict adherence to standardized habitat monitoring and evaluation protocols may stifle creativity on the part of monitoring practitioners if "doing something extra" is discouraged, the risk being that a potentially important environmental factor could be overlooked. For all these reasons, the ISRP recommends that Council should always view habitat action effectiveness monitoring and evaluation as a continuing work in progress, and while there is a need for an appropriate level of consistency to enable broad regional syntheses of status and trends, we doubt that a single standardized habitat monitoring approach is achievable, or even desirable.

On the other hand, the ISRP does feel that improved standardization of measuring fish response to habitat restoration is needed. At the very least, we believe that more tributaries where restoration actions are taking place should be monitored for "adults in" and "smolts out" so that the ratio of smolt production to adult escapement can be established as a tracking metric for monitoring action effectiveness.

The ISRP believes that it is important to consider how long it will take to measure the effects of habitat actions on focal species. The statement in the Council's final decision document for the RMEAP category review (NPCC 2011) that "*The Council will not conclude this review without being comfortable that the monitoring and evaluation protocols and analytical methods are in place to give us a reasonable chance of knowing -- in 5, 10, 20 years -- whether the region's huge investment in an evolving suite of habitat actions is contributing significantly to the recovery and rebuilding of fish species important to the region*" implies that action effectiveness ought to be known in 5, 10, or 20 years if we conduct monitoring in a thoughtful, appropriate, and efficient manner. The question of the time needed to detect the effects of a habitat restoration action, or collection of actions, on target populations seems to be at the heart of uncertainty currently being articulated, including in BiOp rulings, over whether or not the huge investment in habitat restoration will achieve intended outcomes.

There is no standard time frame for expecting measurable results from habitat restoration. In some habitat improvement actions, improvement will be more-or-less immediate and detecting results should be relatively swift and straightforward. The removal of Hemlock Dam on an important steelhead spawning tributary of the Wind River in August 2009 is an example of an action that has had immediate and measurable benefits for Trout Creek. It is also likely that the recent decommissioning of Condit Dam on the White Salmon River will also have immediate benefits. However, other actions may require multiple years for their full benefits to be expressed. These include some types of in-stream structure modifications or floodplain reconnection projects that rely on annual hydrologic fluctuations to complete the task of habitat formation or restoration of ecological function. Still other types of projects, including many riparian forest protection and restoration efforts, require decades for their full benefits to be expressed. In fact, most habitat actions aimed at restoring natural watershed processes fall into the category of projects requiring many years to achieve objectives. Each type of habitat project can be worthwhile, but the amount of time needed to document benefits will vary greatly among them. We thus recommend long-term monitoring for a suite of projects falling into such different categories.

A more problematic issue is the even greater amount of time needed to measure the effects of habitat improvement on fish populations. The ISRP and ISAB have addressed this question several times (e.g., ISAB 2003-2, ISAB/ISRP 2007-5, ISRP 2008-4) and cautioned that the high level of variation in abundance caused by a mix of natural and anthropogenic factors requires that considerable time, sometimes on the order of decades, is needed *both before and after implementing restoration projects* to measure the effects of actions on target populations with a reasonable level of certainty. Many projects simply do not have the time or resources to accomplish a statistically sound evaluation of restoration success. Furthermore, very few projects are able to compare results with an appropriate unimproved reference site, a comparison that is required to accurately identify responses to the application of habitat actions. For this reason, the ISRP has been generally supportive of Intensively Monitored Watersheds (IMWs), which are using a planned experimental approach to evaluating restoration effectiveness at watershed scales. The main point here, however, is that the expectation of definitive answers to the question “Is it working?” may, in many instances, not be achievable in a 5-20 year window. The ISRP therefore suggests that additional dialogue is needed among habitat managers, scientists, and policy-makers so that realistic timeframes can be established, and appropriate schedules agreed upon, to monitor and evaluate different types of restoration actions, and to establish a suite of control and treatment streams, appropriately monitored over reasonable time frames to evaluate success.

Programmatic Issues

The need for inclusion of full life-stage based recruitment information into the effectiveness evaluation of hatchery, habitat, and hydrosystem passage projects has been noted. In addition, there were three programmatic issues identified during this review, including: (1) a need for Structured Decision Management in the Columbia River Basin, (2) implications of precocious maturation of male Chinook salmon (mini-jacks), and (3) potential biases in metrics based on PIT tags. These issues are discussed in the body of this report and several recommendations are provided on each issue.

Structured decision management (SDM): In a previous retrospective report, the ISRP introduced and described the SDM process. Since then, there have been few, if any, direct applications of the SDM approach within the Columbia Basin. There are many example areas where SDM may benefit resource management in the Columbia Basin. For example, the Lower Snake River Compensation Program has recently completed a review and faces decisions on harvest and hatchery policy. Results and models from the recent review could be useful toward this decision process, and much could be gained by including all stakeholders and agencies by applying SDM. Similarly, several habitat projects entail complex decision-making, such as the evaluation of habitat restoration effectiveness, flow augmentation projects (e.g., Walla Walla, Umatilla, Wenatchee), and barge versus in-river modes of hydrosystem passage. Other examples might include predator control (e.g., pikeminnow, sea lions), hatchery production goals versus harvest and wild fish impacts (several areas), recreational versus commercial harvest including selective harvest, largemouth and smallmouth bass or pike recreational fisheries versus salmon and steelhead trout or resident fish recovery, and many other examples. The ISRP encourages application of SDM to these and related management options.

Mini-jacks: Anadromous Chinook salmon and steelhead are known to produce precocious male salmon, that is, young male fish that are sexually mature without going to sea, also called mini-jacks. Progress has been made on evaluating the presence and contribution of precocious salmon among hatchery populations. However, additional research and monitoring is needed to evaluate factors contributing to the frequency of precocious salmon and their abundance in each hatchery. These data are needed to improve estimates of SARs and other metrics associated with hatcheries. For example, SARs based on fish captured and PIT-tagged in the mainstem where a small proportion]of mini-jacks present could produce different results compared with fish PIT-tagged at the hatchery prior to release where all mini-jacks are present. Finally, potential bias in salmon metrics caused by the presence of mini-jacks among hatchery salmon should be recognized and considered by all managers and researchers that rely upon these data.

PIT tags: In the Columbia River Basin, PIT tags are a key tool used to estimate stock-specific survival and migration time of salmonids, including survival of juvenile salmonids emigrating through the system via transportation barge or inriver migration. Decisions to spill more water or to transport more fish around the dams rely upon accurate and unbiased metrics produced by PIT-tagged salmonids. However, recent studies suggest fish may shed PIT tags and/or may experience higher mortality compared with untagged fish, thereby leading to high estimates of mortality. The extent to which tag loss and tag-related mortality may vary from year-to-year and from watershed to watershed are unknown. Given the high value of reliable PIT tag data, additional studies are needed to evaluate the influence on tag loss and tag-related mortality of fish species, fish size, sex, tagging operations, and post-release environmental conditions. These data could be used to develop and apply correction factors, thereby improving the accuracy and precision of metrics that rely upon PIT tags.

2011 ISRP Retrospective

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ISRP Retrospective Report Council Request

- Increase the visibility of project and program results
- Summarize accomplishments of Fish and Wildlife projects
- Summarize status of major basinwide programmatic issues

ISRP Retrospective

- Mainstem
- Habitat Restoration
- PIT Tag Loss and Mini-jacks
- Artificial Production

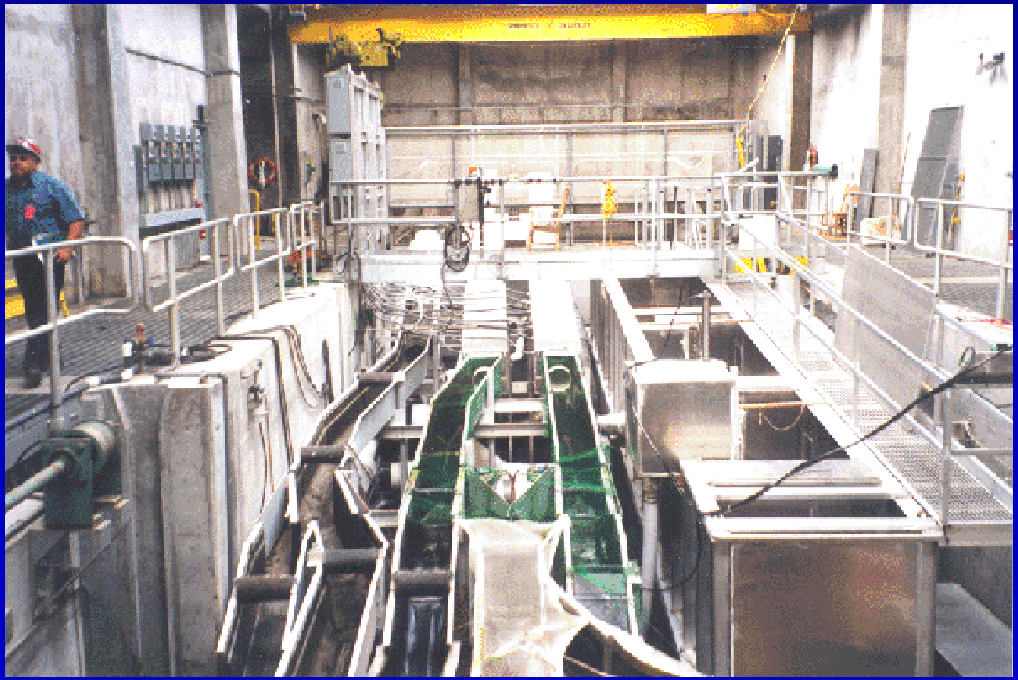
Mainstem

- **Hydrosystem Passage RME & Related Life History Projects**
- **Lamprey Projects**
- **Predation and Competition**

Hydrosystem Passage RME - Support Projects

PIT tag monitoring systems development and data storage, management, and analysis support

- Essential projects
- High priority to develop spillway PIT tag detection systems
- Additional analysis needed of PIT tag loss and tag-related mortality.



Hydrosystem Passage RME - Core Projects

Data collection projects tracking hydrosystem fish passage survival

- Provide long-term data series of smolt-to-adult survival.
- Address management questions.
- Essential projects.

Life History, Population Status, and Hydrosystem/Hatchery Uncertainties

One of these long-term studies has provided the majority of data on listed Snake River fall Chinook and results include:

- Earlier emigration timing for ocean–type wild subyearlings.
- Identification of a reservoir-type wild fall Chinook that overwinters in reservoirs.
- Significant increases in redd counts following supplementation but is there competition – hatchery vs wild?
- Possible density dependent factors as stock size rebuilds.

The ISRP sees the value of long-term data sets as essential and this study serves as a model for other supplementation projects.

Lamprey

Few results to date. Critical questions to address:

- Is dam passage (mainstem and/or tributary) the key limiting factor?
- What is the importance of tributary habitat?
- What is relative importance of ocean conditions and toxic contaminants?

Predation/Competition

- Loss estimates provided
- Importance for recovery of listed salmonids uncertain.
- Recommend large scale life cycle modeling, including mortality from all predators.

Habitat Restoration

"*…the* critical programmatic issue in the RM&E/AP review is whether the collective suite of proposed projects is adequate to monitor and evaluate the effectiveness of our habitat actions in ultimately improving the population characteristics of our key fish species, and to be able to use what we learn to adapt the implementation and management of the program."

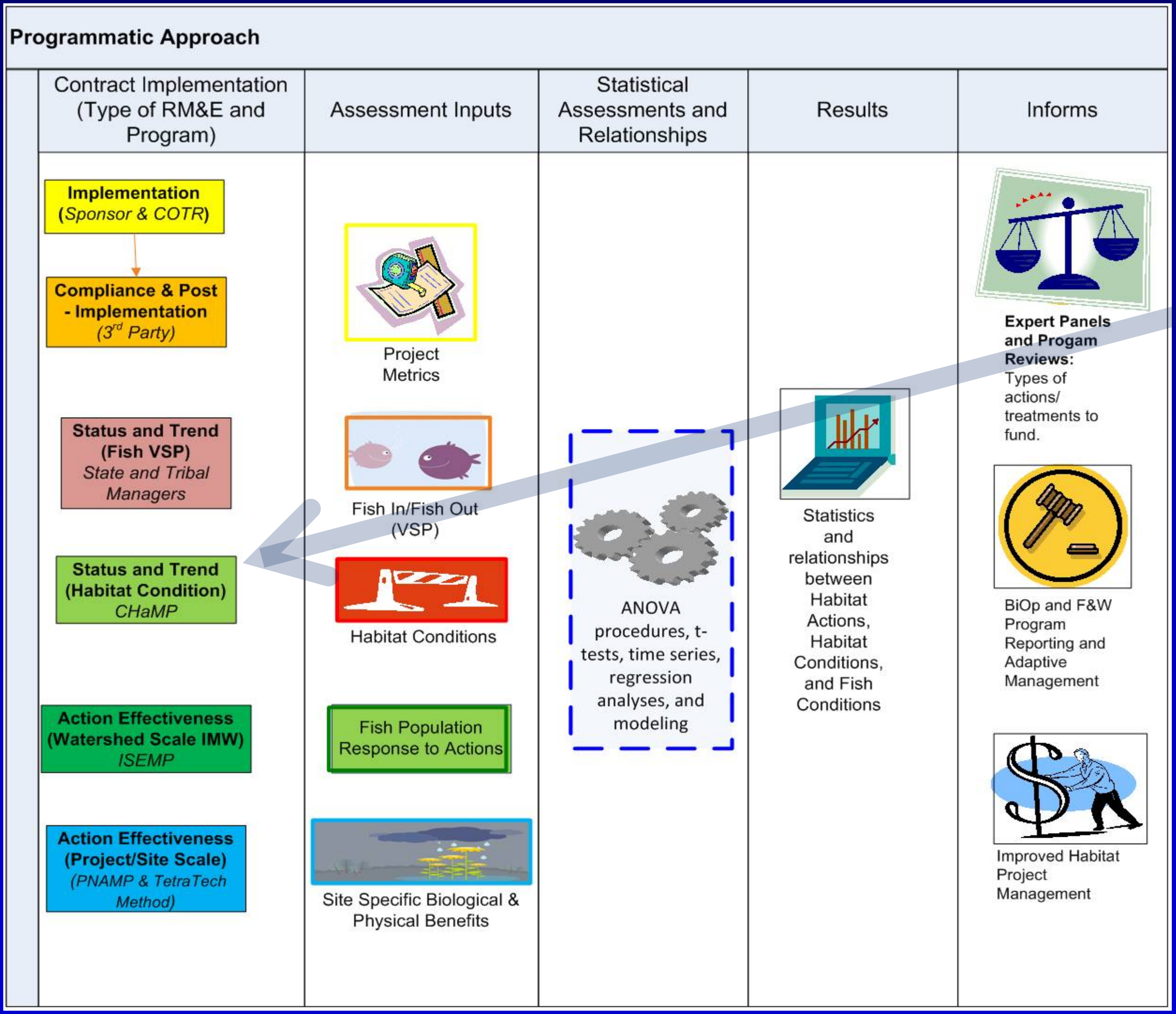
“…in flux or under development”

“…still needs clarity and further definition”

“…reasonable chance of knowing -- in 5, 10, 20 years”

1. Standardizing Habitat Monitoring

Is it feasible to standardize habitat monitoring and if so, is standardization warranted?



Columbia Habitat Monitoring Program (CHaMP)

ISRP 2011-10

Recommendations:

- Habitat effectiveness monitoring is a work in progress
- A single standardized habitat monitoring approach is not achievable or desirable
- Improved standardization of measuring fish response is needed, especially “adults in” and “smolts out”

2. Establishing Realistic Time Frames for Results

How long will it take to measure the effects of habitat actions?

Some improvements will be almost immediate…

Hemlock Dam before removal

After removal

Some will take decades…

Riparian planting, Middle Fork John Day River

Jack Creek, Deschutes National Forest

Determining effectiveness of habitat improvements on fish

- High level of annual variability in abundance
- Limited resources for long-term effectiveness monitoring
- Scarcity of appropriate unenhanced reference sites

Definitive answers to the question “Is it working?” may not be achievable in a 5-20 year window

Recommendation:

Additional dialogue needed between habitat managers, scientists, and policy-makers so that realistic timeframes can be established

Trout Creek above former site of Hemlock Dam

PIT Tag Assumptions

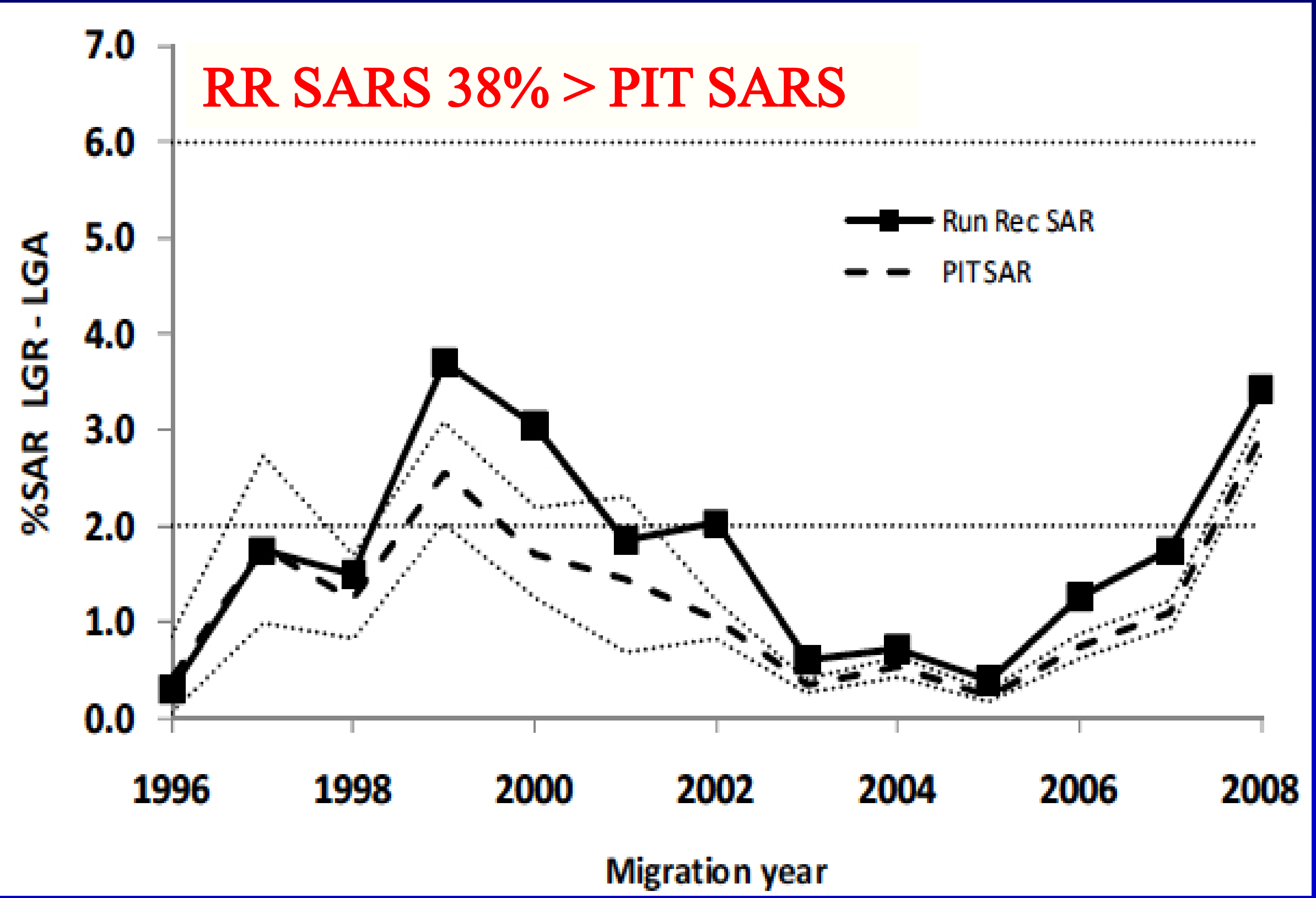
- Tagged fish retain tags.
- Tags do not alter fish growth, behavior or survival.

Species	Mean Tag loss	Citation
Coho salmon	59% ♀ 13% ♂	Prentice et al. 1994
Chinook salmon	18%	Knudsen et al. 2009
Arctic grayling	17%	Buzby and Deegan 1999
Brown trout	20% 56%	Acolas et al. 2007 Dieterman and Hoxmeier 2009
Cutthroat trout	26%	Bateman et al. 2009

Run Reconstruction v. PIT Tag SARS
Snake R Wild Chinook

SARS influenced by both tag loss (18%) & tag-related mortality (10%).

Knudsen et al. 2009

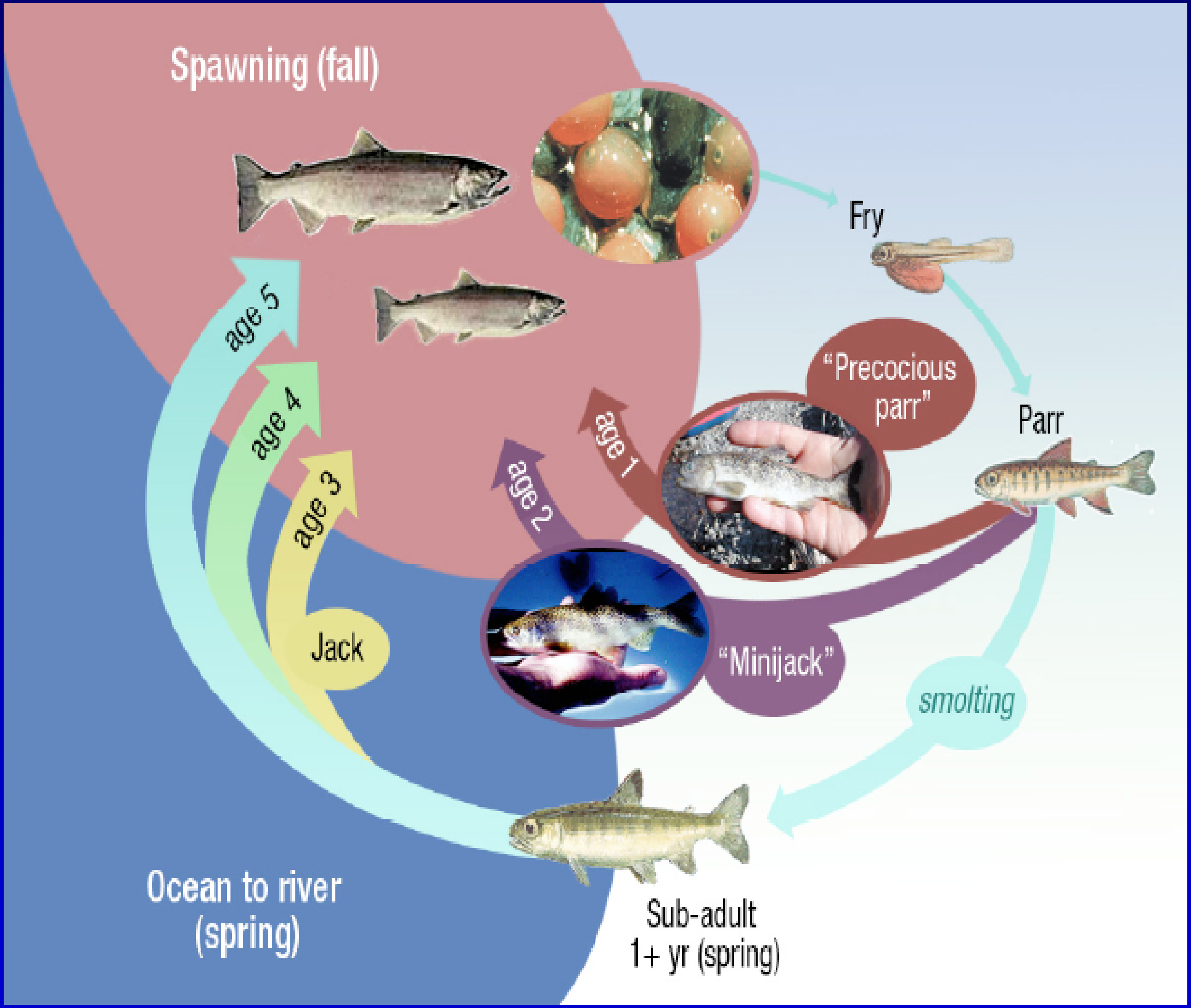


CSS 2011

Key Concerns & Recommendations

- Variability in PIT tag loss and mortality in relation to species, fish size, ecological conditions, and tagging personnel.
- Increasing tag loss with salmon age (Snake R Chinook).
- Need to further evaluate PIT tag loss and tag-related mortality.

Mini Jacks and Precocious Male Salmonids



Larsen et al. 2010

Why are Mini Jacks Important?

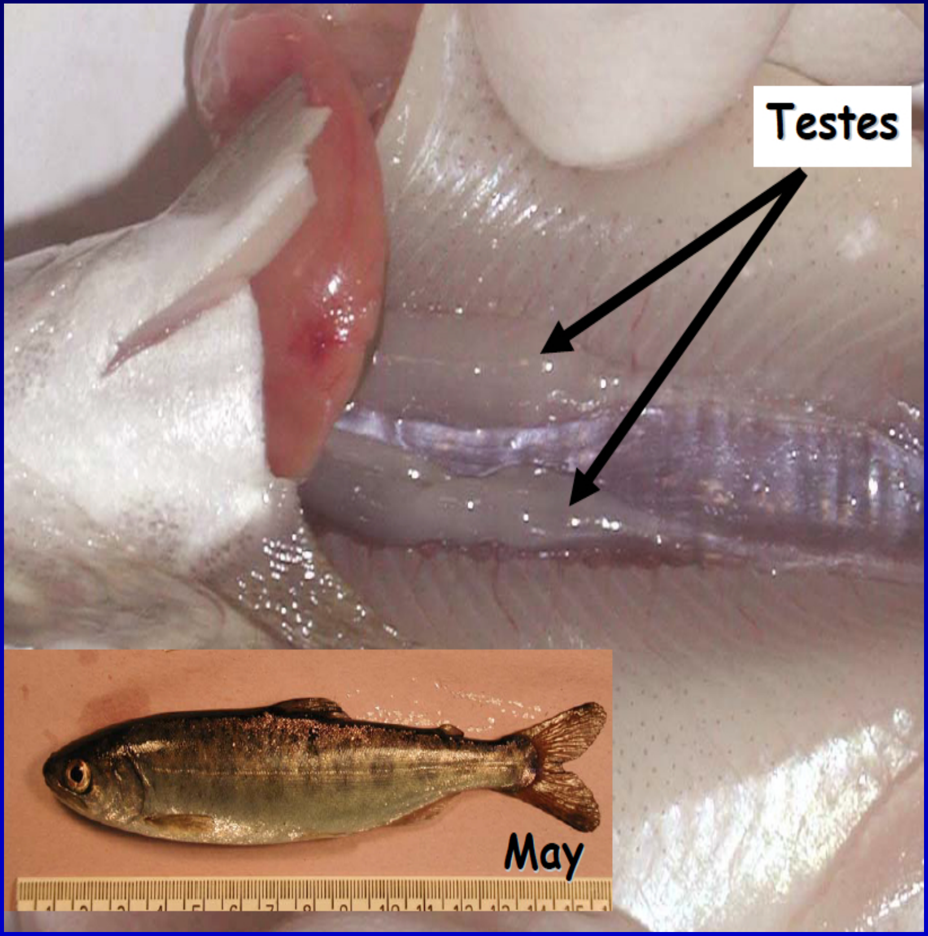
Potentially abundant among spring & summer Chinook at hatcheries (10-52% of males).

May significantly reduce SARS (e.g., 25%).

Economic, ecological, and genetic impacts.

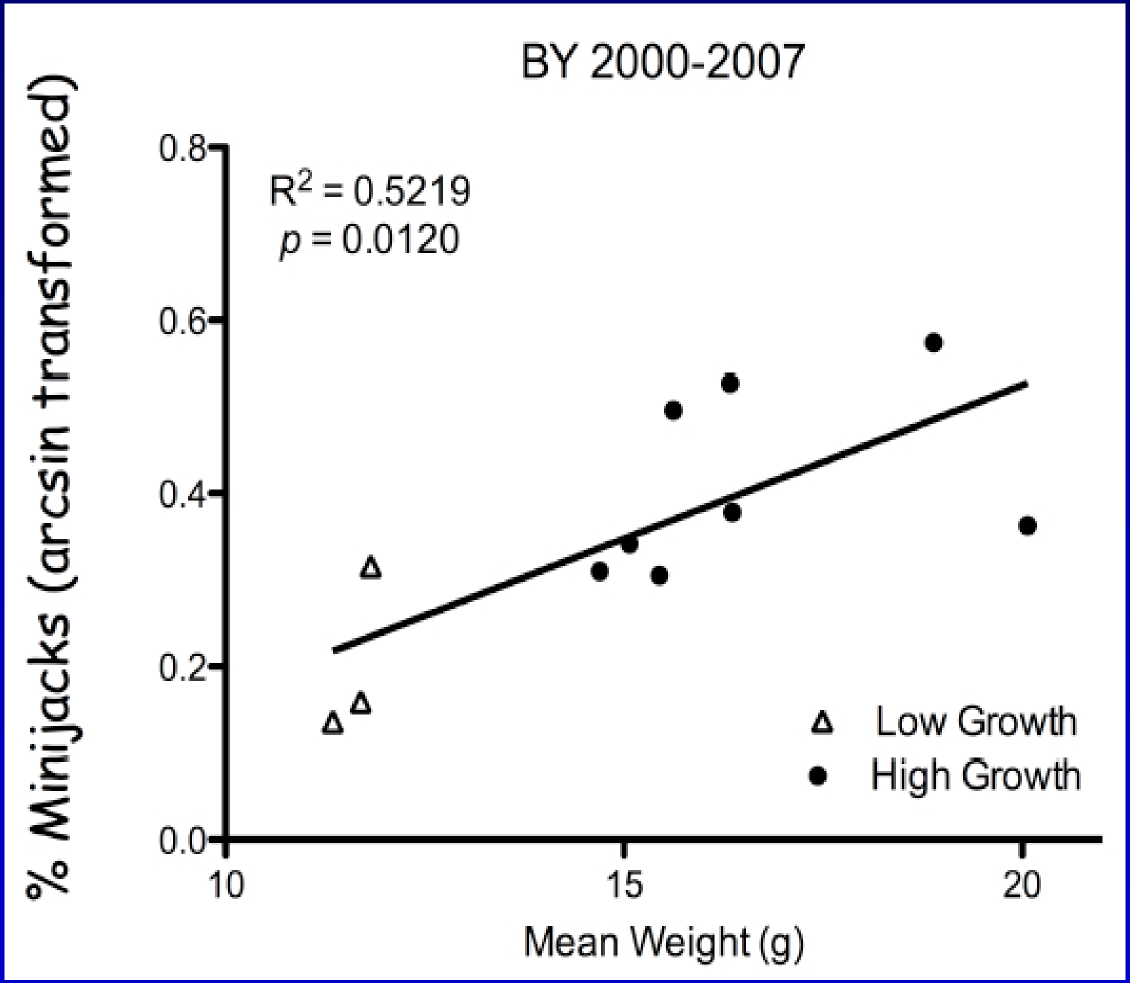
Integrated hatcheries (natural broodstock) may produce more mini-jacks.

Mini-jack rates in hatcheries are 10-20 times higher than in wild.



Growth Affects Mini-Jack Rate

NOAA Fisheries is looking at a variety of factors affecting mini-jacks, including season of rapid growth & genetics.



Larsen et al. 2010

Artificial Production

Research Topics

- Relative Reproductive Success
- Gamete Preservation
- Hatchery Reform
- Kelt Reconditioning
- Sockeye Salmon

Relative Reproductive Success

Steelhead

Non-local “domestic” stocks <<<

1^{ST} Generation Local =

2^{nd} Generation Local <

Multi-Generation Local <<

Genetic Effect (H_{WW} versus H_{NN})

Carry-over Effect (N_{HH} versus N_{NN}

Relative Reproductive Success

Spring Chinook

Wenatchee River
- 1st Generation Local = 50%
  - Females – Correlated w Location
  - Males – Significant Post Correlation

Catherine Creek – Grande Ronde R.
- Parr 103%
- Migrants 100%
- Returning Adults 77%

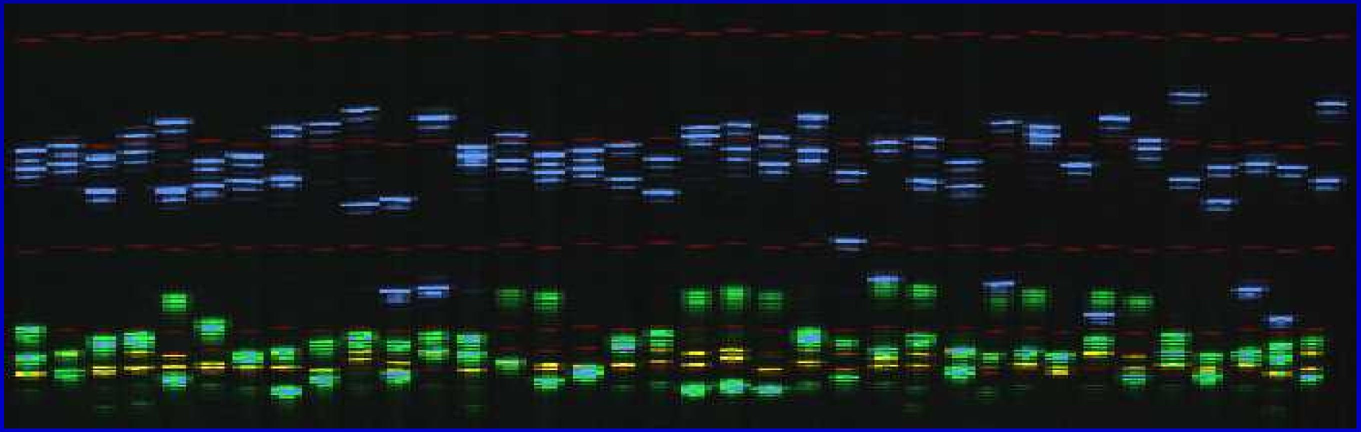
Relative Reproductive Success

ISRP Conclusions

Replication, Gaps, Study Longevity

Coordination and Integration of Projects

Environmental Correlates and Mechanisms Research



FWP Hatchery Monitoring and Evaluation

ISAB and ISRP APR Metrics

Same Metrics used in LSRCP

1. Performance in Hatchery
2. Performance Post-release
3. Impacts on Natural Populations

Fish and Wildlife Program Production Initiatives

Performance in the hatchery

- Performance indicators and quantitative objectives?
- Adequately measured, reported, and analyzed?
- Able to achieve project goals?

Recommendations: Conform to Council APR Indicators
Clearly defined standard and report on whether achieved
Update a table of performance annually
Establish comparisons across programs

Fish and Wildlife Program Production Initiatives

Performance Post Release

- Performance indicators and quantitative objectives?
- Adequately measured, reported, and analyzed?
- Able to achieve project goals?

Conclusions: Hatchery smolt survival and migration difficult to interpret
Adult SAR and harvest inconsistently measured and reported
Substantial full life-cycle advantage
Harvest opportunities increased, but objectives not met

FWP Hatchery Monitoring and Evaluation

Impacts on Natural Populations

- Performance indicators and quantitative objectives?
- Adequately measured, reported, and analyzed?
- Able to achieve project goals?

Conclusions: No effective indicators for ecological or genetic impacts
Supplementation evaluation incomplete

Fish and Wildlife Program Production Initiatives

Supplementation Evaluation

Performance Metrics
- Natural Origin Adult Abundance
- Intrinsic Productivity

Evaluation
- Treatment x Reference Stream
- Before-After-Control-Impact (BACI)

Natural spawning by Hatchery-Origin adults is the treatment in a supplemented stream, not the response variable

Fish and Wildlife Program Production Initiatives

Supplementation Results

- Imnaha spring Chinook BACI
- Umatilla summer steelhead BACI
- Density Dependence

Conclusions

- Evaluation of abundance and productivity required
- Absence of empirical evidence to assign a conservation benefit
- Long-term use of sliding scale is risk to population viability
- Investigate causes of density dependence