Summary of the
Northwest Power and Conservation Council's
Science-Policy Exchange

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Portland, Oregon

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NPCC Science-Policy Exchange Summary

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Background

The Northwest Power and Conservation Council hosted a two-day Science-Policy Exchange in Portland, Oregon on September 12-13, 2007 that focused on the current state of scientific knowledge about salmon and steelhead in some of the thorniest fish and wildlife policy issues of the day. Topics included examining the efficacy of freshwater habitat restoration; survival of salmon and steelhead past the hydroelectric dams on the Columbia and Snake rivers; survival of salmon and steelhead in the Columbia River estuary; and survival in the Pacific Ocean. The Science-Policy Exchange helped set the stage for the amendment process for the Council's Fish and Wildlife Program (FWP). The year-long amendment process starts in November 2007. The Council revises the program every five years.

The Northwest Power Act directs the Council to use the best available scientific knowledge when amending the program, so the Science-Policy Exchange focused on helping policy-makers learn the current state of science on emerging issues in fisheries and wildlife science that are critical to the Fish and Wildlife Program. Emerging issues, such as the role of estuary and ocean environments in juvenile salmon and steelhead survival, are often complex and filled with uncertainty, making the translation from science into representative policy difficult.

Purpose and Format of the Exchange

The purpose of the Science-Policy Exchange was to highlight several of these emerging issues through briefings by some of the region's top scientists and managers. Eighteen scientists from state, federal, and Canadian fish and wildlife agencies, Indian tribes, and the Council made presentations on four major themes: habitat restoration and monitoring, mainstem survivals, estuary habitat and survivals, and ocean tagging and survivals. Presentations are posted on the Council's website: http://www.nwcouncil.org/fw/program/2008amend/spe/agenda.htm. Presentations focused on summarizing the state of the science for each topic, as well as identifying critical research needs and data gaps. Presentations were followed by vigorous round table discussions among the Council members, other policy-makers, scientists, and fish and wildlife managers.

This format helped bridge the gap between science and policy, by focusing on the results (rather than methodologies) of research and relating that back to program implications. Council members are used to getting formal, one-topic, once-monthly unrelated panel discussions with limited scope of discussion and range of participants. Consequently, having succinct presentations that summarized the state of the science followed by an interactive discussion with scientists and managers, allowed Council members to hear the same thing at the same time, in a focused session out of the ordinary decision-making role. It was more relaxed, and policy makers, scientists, and fish and wildlife managers were encouraged to talk, ask, probe, and discuss the policy implications of new scientific knowledge. Everyone heard the same information even where there wasn't scientific consensus or clear conclusions. People walked away with a common understanding of the latest science.

Rick Williams, a scientist from Eagle, Idaho, moderated the two-day exchange. Dr. Williams, former chair of the Council's Independent Scientific Review Panel and an expert in population and evolutionary genetics and ecology, facilitated the Science-Policy Exchange and helped focus the discussion sessions on the policy ramifications of the emerging scientific issues and how they might inform the upcoming Fish and Wildlife Program amendment process.

Results and recommendations from the Exchange are presented below based around the habitat, mainstem, estuary, and ocean themes. For each theme, the report includes: the guiding assumptions from the Fish and Wildlife Program; the state of current science; consistency of the current science with program assumptions; and policy recommendations or implications derived from the roundtable discussions. Each session ends with the questions, answers, and insights from the roundtable discussion period.

Session I: Habitat

A. Intensively Monitored Watersheds (IMWs)

Overview	Bob Bilby
Fish Creek Case Study	Gordon Reeves

B. Habitat Strategies

Overview	Susan Hanna
Strategies and Solutions	Peter Paquet

C. Nutrient Enhancement

Overview	Pete Bisson
Case Studies	Matt Mesa

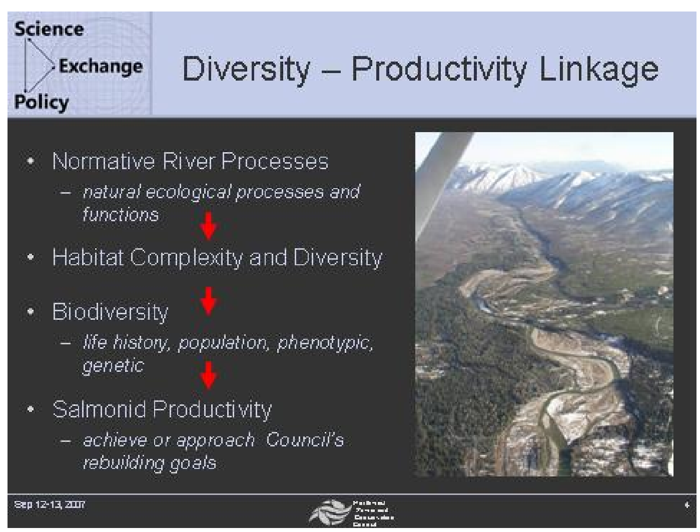
Habitat Session: Background and Overview

Scientific Assumptions in the Fish and Wildlife Program

The assumptions in the Fish and Wildlife Program are incorporated in its Scientific Principles that were largely derived from a framework / conceptual foundation developed in the Independent Scientific Group's "Return to the River." The assumptions relate habitat diversity and complexity, which are created by natural riverine processes, to the development and persistence of biological diversity, including salmonid productivity, resilience, and sustainability.

Fish and Wildlife Program Scientific Principles

1. The abundance, productivity and diversity of organisms are integrally linked to the characteristics of their ecosystems.
2. Ecosystems are dynamic, resilient and develop over time.
3. Biological systems operate on various spatial and time scales that can be organized hierarchically.
4. Habitats develop, and are maintained, by physical and biological processes.
5. Species play key roles in developing and maintaining ecological conditions.
6. Biological diversity allows ecosystems to persist in the face of environmental variation.
7. Ecological management is adaptive and experimental.
8. Ecosystem function, habitat structure and biological performance are affected by human actions.



Conceptual Foundation from Return to the River

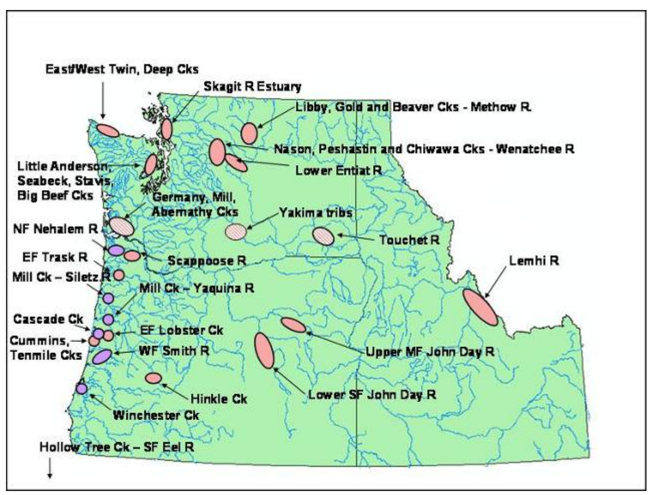
A. *Intensively Monitored Watersheds (IMWs)*

Current habitat activities within the Columbia River Basin are consistent with the Fish and Wildlife Program's Scientific Principles. The Council's desire is to link habitat improvements and restoration to salmon and steelhead rebuilding goals and fiscal accountability. This is particularly evident in the IMW (Intensively Monitored Watershed) projects where detailed monitoring protocols are linked with specific habitat restoration and improvement projects in an effort to understand the effects of habitat projects on salmonid populations and their habitats. Policy questions of interest to the Council included such things as: What is our ability to detect changes in habitat and salmon populations over what time period? How long do the projects need to run in order to get meaningful results? Will the results apply to other subbasins and species? The Council members want to be able to link habitat work to fish response to assess the success of the program, and so on.

Summary of Current Scientific Findings

Robert Bilby, an aquatic ecologist with the Weyerhaeuser Company, and Gordon Reeves of the Corvallis office of the U.S. Forest Service Pacific Northwest Research Station, discussed using intensively monitored watersheds (IMWs) as watershed-scale experiments to accelerate scientific understanding of salmon and steelhead response to changes in spawning and rearing habitat.

Millions of dollars have been dedicated to the restoration of freshwater habitat in the Pacific Northwest since the 1980s. The efficacy of these efforts is not fully understood; however, such an understanding is critical in order to most effectively distribute restoration resources and to estimate the contribution of these activities to the recovery of listed salmon Evolutionarily Significant Units (ESUs) in the Columbia Basin. Coordinated research through a system of intensively monitored watersheds (IMWs) is necessary because of the numerous factors affecting fish survival. Traditional monitoring efforts aren't capturing the necessary data to evaluate the effects of habitat restoration on survival. This is because salmon don't spend their entire lives in the river, climate variation, and complex estuary dynamics. The IMW approach will help distinguish the varying influences of different factors from one another. In order to get an accurate and comprehensive perspective of the affects of habitat restoration, it is necessary to implement monitoring at the scale of an entire watershed. This approach encompasses the full array of habitat types. The magnitude of this scale is expensive, so smaller watersheds have been selected as more cost and time effective, because we need the results from these studies sooner than the five decades other approaches might require.

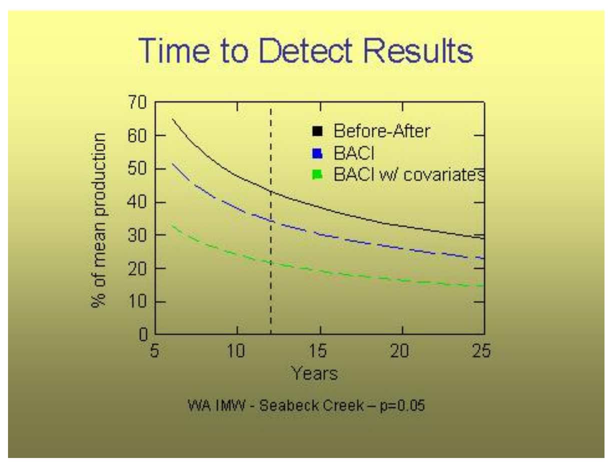


IMWs in Washington, Oregon, and Idaho

One of the most effective means of determining restoration projects' contribution to salmon recovery are watershed-scale experiments. Several organizations in the Pacific Northwest have begun to establish such projects, termed Intensively Monitored Watersheds (IMWs). The premise of this approach is that the complex relationships controlling salmon response to habitat conditions can best be understood by concentrating effort at a few locations. Focusing effort enables enough data on physical, chemical, and biological attributes of a system to be collected to develop a comprehensive understanding of the factors controlling salmon production and how these factors are influenced by the application of various restoration measures. Concentration of effort also enables a large number of restoration projects to be deployed over a short period of time, greatly increasing the ability to detect a fish response, should one occur.

Many IMW efforts have been implemented in the last five years, particularly along the Oregon and Washington coast; however, recent efforts are also underway east of the Cascade Mountains in Washington, Oregon and Idaho. Some of these studies are designed to evaluate the efficacy of various land use regulations on aquatic habitat and fish and others are focused on responses to restoration actions.

The design approach to IMWs varies. One option is the paired watershed approach either conducting monitoring and evaluation before and after restoration, or selecting two similar systems and using one as the reference and the other as the study site. The IMW approach allows a more detailed investigation into the processes that determine salmon survival. Regardless of the approach, all IMWs collect similar data on physical and chemical parameters, return numbers, summer abundance, and numbers of smolt leaving the system. The most common design is a paired-watershed experiment with a BACI design. There are other IMW designs looking at specific habitat processes. Most are measuring comparable data – the number of returning adults, parr abundance, and migrating smolt information.



Two concerns about IMWs have been raised. First, the variability in salmon populations would suggest that the length of time required to obtain meaningful results may be considerable. Second, there is uncertainty in extending IMW results to other locations. IMWs have begun to address these concerns. The design of most current IMWs includes untreated, reference watersheds and attempts to account for co-variates (factors influencing the fish, but not related to applied treatments). Power analysis of data collected at a Washington IMW using this approach indicates that detecting a 25% response in smolt production should be possible in about a decade. Many IMWs should have a comparable timeline. Thus, by concentrating monitoring of habitat restoration in a small number of watersheds in Washington, Oregon, and Idaho, scientists should be able to detect a significant response in the production of salmon smolts in about 10 years as opposed to a 20-30 year horizon for less intensive monitoring.

Uncertainty associated with extending IMW results to other locations will ultimately be reduced as results from the large number of IMWs established recently become available. Another important element in extending the results of IMWs for the study area to other areas are regional efforts, such as NOAA Fisheries, to develop habitat classifications and map those across the basin. Consequently, IMW results evaluating actions in a particular habitat type might be inferred to extend to similar habitat types in other areas of the basin. The information generated by IMWs also will improve the accuracy of the models currently being employed to predict fish response to habitat actions. These improved models will facilitate broad application of IMW results.

Gordon Reeves (US Forest Service, Corvallis) summarized results and lessons learned from three long-term monitoring efforts of 6-16 years duration in western Oregon. The efforts involved the monitoring of a major restoration effort (Fish Creek, tributary of the Clackamas River), the annual variability in the distribution of fish and habitat (Elk River), and variability in smolt production from several watersheds (Upper Clackamas River).

The project's objective was to increase the number of pools for summer rearing and to increase survival of juvenile Coho. Large wood was placed into the channel and cabled down. The habitat goals were achieved rather quickly; the project doubled the number of pools, but decreased the number of riffles. Juvenile coho and steelhead decreased by up to 50%, yet coho smolts increased by 13% and steelhead yearlings and smolt output increased by 12% and 28% respectively. The results were not statistically significant due to high variation over the study period, which included the floods of 1996, but were ecologically significant because of the greater output of larger fish.

Primary lessons from the three Oregon studies were:

1. The effects of restoration work may not necessarily be seen in an increase in the number of fish in or leaving a basin, but may be expressed at the size of the fish;
2. It is unlikely that every species or age-class will respond the same way;
3. There is a lot of variability in both physical and biological conditions within and among watersheds over time; and
4. In-channel work is a catalyst to recovery and should be accompanied by concurrent restoration of key ecological processes that create and maintain habitat over time.

Policy Implications for the Fish and Wildlife Program Amendment Process

Policy questions that arose from the discussion following presentations on IMWs focused on the length of time needed for studies to provide results, the dollar investment of those long-term studies, the Council and regions' commitment to that investment, and whether additional interior IMW sites were needed to bolster the ability to extrapolate to other interior sites from the few current interior IMWs.

More specific policy-related questions were:

1. Monitoring for extended time periods (i.e., 15-20 years) in some selected situations is crucial to adequately assessing the impacts of restoration and recovery efforts.
2. Habitat response can be very fast. Monitoring needs to focus on what are the ecological processes and identifying the impacts of large events, such as floods or forest fires.
3. Most IMW sites are in the coastal forests and watershed. Only a few IMWs occur in the interior Columbia; for example, only one in Idaho on the Lemhi River. We may need more interior sites in order to be able to extrapolate from the interior IMWs.
4. What level of change and detectability are we looking for in the IMWs? Is there a difference between biologically significant results and statistically significant results? If so, this should be addressed ahead of time, rather than later. Timelines required to achieve the two sets of results may be significantly different.
5. If additional IMWs are to be established, what criteria will be used to identify them? One approach would be to look for areas where existing datasets exist, like the Grande Ronde.

Roundtable Discussion Points

Tom Karier (Council Member, WA)
In addition to understanding a set of actions, we also need to understand the effect of single actions, such as culvert removal and increasing flows.

Gordie Reeves (USFS scientist) and Bob Bilby (ISAB)
Some IMW are actually looking at these type of actions.

Rick Williams (Facilitator)
The policy-science question is whether we have enough IMWs in the interior Columbia River Basin. Do we need more to allow transferability across the basin?

Melinda Eden (Council Member, OR)
There are a lot of IMWs on Coast. What are the impediments to extrapolating to the Columbia River streams?

Bob Bilby (ISAB)
NOAA classifications should be coming out soon. Most work is on the Coast because the research institutes are located nearby.

Rich Carmichael (ODFW)
We need to qualify statements on habitat response depending on type of habitat limitations. For example, is the limitation a process, like flow? If so, it can take a lot longer to restore. How do we manage the larger processes, like wood delivery?

Gordie Reeves (USFS scientist) and Bob Bilby (ISAB)
The storms deliver the large woody debris, so you can manage by growing large riparian trees and decommissioning roads. What are the processes for long-term productivity?

Jim Kempton (Council Member, ID)
Where (geographically), given the fact that funds are limited, should watersheds be monitored intensively? Also, can the IMW approach be used on stream segments or confluences? What is the most effective way to conduct monitoring?

Gordie Reeves (USFS scientist) and Bob Bilby (ISAB)
There are a large number going on. The coast is covered, but the interior may not be adequately represented. For example, we only have the one site in Idaho. We need more in Idaho and the Salmon River basin in particular. They will provide the detailed information needed while still providing a basin wide perspective. It is important to have a set of IMWs across the basin to get more detailed data. Standard monitoring should also take place. With respect to monitoring scale, the IMW design can tee-off a confluence - one control, the other treatment. Restoration strategies are applied in combination to address what the limiting factors are.

Pete Bisson (ISRP)
How long is long enough to monitor an IMW site? It's difficult after 17 years to get any statistically significant. What would it take to see a 30% change?

Gordie Reeves (USFS scientist) and Bob Bilby (ISAB)
We need to separate biological significant from statistical significance, as they don't always coincide. For example, in Fish Creek, you'd get on blip that would throw off the statistical significance. How do you define success? It needs to be defined biologically (and politically?).

Rick Williams (Facilitator)
The emerging policy question from the above discussion is "What is the level of change we are looking for, what is the time line needed to obtain it?" At present, the region has not had this discussion.

Rich Carmichael (ODFW)
Did the restoration activities effect the flood response? Paired watersheds are valuable because you need to account for land-use management. Many response variables are highly variable.

Gary James (Scientist, Umatilla Tribe)
We need some criteria for where to establish IMWs. The program should look at areas with good data sets – such as the Grande Ronde. Also look at areas with large changes such as the Umatilla.

Bill Booth (Council member, ID)
Dollars are scarce, not only for research but also for implementation. We need to bring the studies to a close and identify practical implementation results. It's always hard to close out studies. The program needs help establishing a point to stop the research phase.

Gordie Reeves (USFS scientist)
There's a desire to get these things done fast, but the example from Fish Creek tells us that you need to take a longer term approach and to stick with it. Shorter-term results can be misleading.

The scientific findings show that response variables can be highly variable. Therefore, we need to design experiments and monitoring using a before after control (BACI design). We're spending a lot of money on projects without controls, in most cases. This is a huge issue.

Bob Bilby (ISAB)
The ISRP can look at this in their reviews. The ISAB and ISRP have long advocated for a coordinated monitoring and evaluation approach. This is different from the project specific monitoring needed to show project fulfillment, but not necessary at the level biological response.

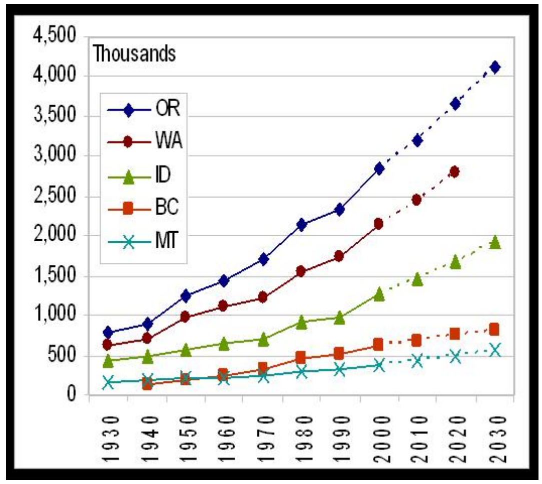
Chris Furey (BPA)
How do you get the research from the IMW in Chris Jordan's study linked to subbasin plans?

Rick Williams (Facilitator)
The region's investment in IMWs demonstrates evidence of commitment to habitat action and understanding the effectiveness of those actions.

B. *Habitat Strategies*

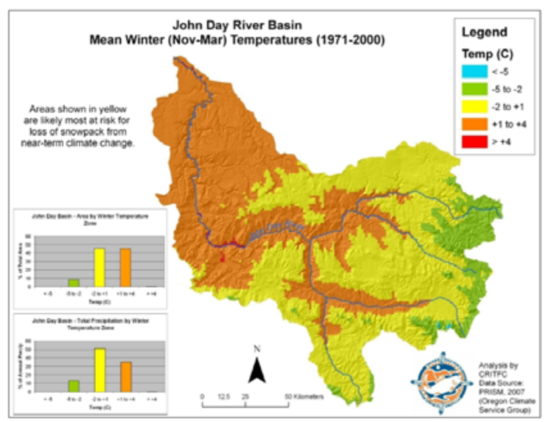
Summary of Current Scientific Findings

Susan Hanna, a professor of marine economics at Oregon State University suggested it is time to rethink an important assumption in the Fish and Wildlife Program – that human population and climate will remain stable over time. In fact, population is growing, the climate is changing, and this introduces major uncertainties into habitat restoration strategies. Climate change will influence the timing and quantity of water. Human population has been steadily increasing and these increases are projected to continue. Change in climate and human population lead to specific habitat effects through alterations in water quantity and quality, conversion of forestland, farmland and ranchland, modified development patterns and increases in airborne pollution and invasive species. Because of the importance of these habit impacts, habitat strategies have to deal not only with physical and biological elements of habitat protection and restoration, but also with economic and social aspects. Recent Council reports on climate change (ISAB), population growth (ISAB), and strategies for habitat acquisition (IEAB) contain recommendations for strategies to deal with these changes that include planning processes, tools, and coordination.



Population growth and projected growth

Peter Paquet, manager for wildlife and resident fish for the Council, highlighted some of the more promising strategies for identification and protection of critical habitat under conditions of uncertainty. Effective application of mitigation measures will require identification of those locations where they will have the greatest benefit. Locations especially sensitive to climate and population change and with high ecological value are prime conservation targets. Future assessments need to take into account two interrelated processes: socio-economic change and climate change. For example, some 40 percent of the John Day River Basin in Oregon is at an elevation predicted to lose snowpack in the future as the result of climate change. The message for policy-makers is that habitat with high ecological value, but that also is most sensitive to impacts from climate change and population growth, should have priority for conservation and mitigation actions. Some of what is currently high value habitat for species of concern is likely to decline in value for those species, while other high quality habitats will develop with predicted changes in climate. These changes need to be reflected in future planning processes.



To date, future changes in populations and climate have not been sufficiently integrated with habitat assessments. Most effort in "futures modeling" has focused on extrapolating past trends rather than envisioning alternative futures. A number of currently used methods may prove promising in future iterations of subbasin planning and other regional efforts as they attempt to incorporate climate and population change parameters. These include tools such as EDT, IBIS, CLAMS, and more recently developed models, such as proposed by Schaller and Budy, particularly if they are used in conjunction with an Alternative Futures Analysis process.

Gary James, fisheries program manager for the Confederated Tribes of the Umatilla Indian Reservation, noted that the tribe's habitat work suggests that flood plain restoration would be an effective mitigation strategy against the reduced summer flows anticipated as a result of climate change, as broadening the natural flood plain of a river allows cool water from underground to rise into the river and cool the surface-water temperatures.

Policy Implications for FWP Amendment Process

The habitat restoration approaches and strategies discussed in this portion of the Habitat Session are consistent with the Fish and Wildlife Program's Scientific Principles. The Scientific Principles acknowledge that ecosystems are dynamic, resilient, and develop over time. But the principles do not specifically address human population growth or climate change and the rapid change that is occurring for both these factors.

Policy issues to emerge from the habitat strategies discussion included:

1. Because both issues (climate change and human population growth) have the potential to have very large impacts on water use and availability in the Columbia River Basin in the future, it is recommended that the program amendment process explicitly address these issues – at least at the planning level, if not beyond. An examination of the future predictions of water availability and temperature changes, as well as habitat loss and degradation, should be included in the planning. Prioritized strategies and actions could then arise from this planning effort.
2. Protection of cold-water refugia for migrating salmon and restoration of riparian habitats in headwater reaches should have high priority.
3. Habitat protection actions should be directed at the best available habitats. Planning for these actions needs to include present and predicted future conditions taking into account climate and human population change impacts. That is, the best habitats today might not be the best habitats in the future. Do we protect the current best, invest in restoration activities in habitats that might be predicted to be better in the future, or do we attempt a balanced program of both strategies? Actions need to balance protection of key habitats in the program with the ever-present focus on weak stocks and their habitats.

Roundtable Discussion Points

Tom Karier (Council Member, WA)
How much of this strategic planning requires simple incorporation of models into subbasin plans and how much requires major changes in restoration actions? How should policy plans change, should we invest in upper basin because lower is too hot?

Peter Paquet (Council staff and presenter)
We can begin to incorporate the information we have today. The bottom line is we don't currently know results. Water availability will change. We'll have more coastal precipitation in the form of rain instead of snow. We can't say with any certainty how well we'll be able to incorporate these factors until we do the planning, modeling, and see results.

Manager perspective
So far we haven't been able to get scientists to develop scenarios -- how do you incorporate these elements and run models to suggest policy? Many of the expected climate change factors are similar to what we have already seen. For example, significant hydrograph changes have occurred, and strategies are already developed to deal with these changes. These and other ongoing restoration and mitigation strategies may be useful for dealing with climate and population changes as well.

Joan Dukes (Council member, OR):
Do we have enough information on climate change to guide specific actions?

Gary James (Scientist, Umatilla Tribe)
We don't have information that is specific enough. Temperature is always a limiting factor. One thing we can do in a western landscape where water will become more limiting is to develop broader valley natural function. This can be done by fencing riparian zones. Increasing riparian habitat will increase the system's hyporheic function. We need to preserve the width of natural floodplain function, which allows streams to meanders and reduces temperatures in the hyporheic zone. This can lower water temperature, which varies by reach. Every flood plain provides an opportunity to lower water temperature and increase water retention.

Susan Hanna (ISAB and presenter)
Do we have enough scientific information to affect policy?

Bob Bilby (ISAB)
Information, including that from the Climate Impacts Group, is becoming available at scales appropriate for subbasin planning.

Rick Williams (Facilitator)
Models are not predictive; they allow evaluation of different sets of assumptions for future climates.

Peter Paquet (Council staff and presenter)
Bayesian networks work better as predictive models than others (EDT, IBIS, etc.). It has been used effectively on polar bear population models.

Pete Bisson (ISRP)
Climate change models predict increased frequency of large natural disturbances such as fire and floods. Peter Paquet said to protect the best habitat first. Given that models suggest increase in dramatic events, to what extent should managers attempt to suppress these events? Should we attempt to take into account long term benefits?

Rich Carmichael (ODFW)
We are dealing with how aggressively to approach fuel reduction in terms of effects on steelhead. There is emerging evidence that intense fires have generated benefits in terms of nutrient release.

Susan Hanna (ISAB and presenter)
Forest fires are an example of the interface between effects of climate and population growth.

Will Conley (Yakima Tribe)
We saw after the Yellowstone fires, that people's perceptions of the fire were negative; however, on the ground lots of good things were going on.

Rick Williams (Facilitator)
What are our priorities for habitat restoration and protection given our limited resources? What has been the success of water banking and transfer programs? We will need more as water becomes more scarce?

Russ Kiefer (Idaho Fish and Game)
Most of the money today is applied opportunistically into habitats that are in the most trouble now. A dual strategy might be to focus short term funds to places that are currently productive and/or offer the best bang for the buck, while looking long term to invest in sites predicted to be best in future.

Peter Paquet (Council staff and presenter)
Yes, best today may not be best in future. Major habitat protection implications. Shifts in populations and species. Have to deal with policy implications.

Teresa Scott (WDFW)
The FWP amendment process should be more explicit in incorporating population growth and climate change. Subbasin planning underestimated cultural impact on planning process. We need a much bigger pool of money than the FWP alone, and the people in the watershed are the ones who need to advocate for broader funding. Another avenue is for people to consider how they affect their natural environment.

Susan Hanna (ISAB and presenter)
Most subbasin plans did not address human demographic change. Planning for the Willamette Valley is an exception; there was great access to funds. Economic development and alternative futures were explicitly incorporated. Do we protect the best, or keep throwing money at the worst? The program needs a picture of where it wants to go. This makes it easier to make decisions along the way. Achieving goals may be difficult if money is all focused on degradation.

Linda Hardesty (ISRP)
Many subbasin plans did not get to stage of prioritizing limiting factors, strategies, or future actions, but this needs to be done.

Rich Carmichael (ODFW)
The fish and wildlife program needs money for strategic objectives. Protect best, enhance what's good, restore worst last -- incorporating cultural contexts makes it more complicated.

Stuart Hurlbert (ISAB)
The two major threats of population growth and climate changes are radically distinct. There's not much we can do locally to affect the near term inertia of climate change, but population can be dealt with better regionally.

C. Nutrient Enhancement

Scientific Assumptions in the Fish and Wildlife Program

The Fish and Wildlife Program does not have assumptions specific to the issue of nutrient enhancement. Habitat assumptions include links between habitat diversity and complexity to salmonid diversity and productivity. Implicit in these relationships is that healthy habitat would support food webs that would support salmon productivity. Nutrient enhancement strategies use technology (salmon carcasses or carcass analogs) to supplement the base of the food web under the assumption that this will result in increased juvenile survival, which in turn translates into increases in adult survival and returns.

Summary of Current Scientific Findings

Peter Bisson, a research biologist with the Forest Service in Olympia, and Matthew Mesa of the U.S. Geological Survey's Columbia River Laboratory discussed nutrient enhancement of rivers and streams as a tool to boost production of food organisms for fish, which in turn might lead to increased fish production. Using nutrient additions to enhance salmon began in Alaska in the 1930s, when inorganic nutrients (primarily phosphorus) were added to nutrient-poor oligotrophic lakes to improve the growth of young sockeye salmon.

The technique of lake fertilization was adopted by salmon managers in British Columbia in the late 1960s and became one of the cornerstones of B.C.'s Salmonid Enhancement Program. Studies of large sockeye-producing lakes such as Great Central Lake on Vancouver Island showed nutrient additions improved growth, which resulted in greater smolt-to-adult survival. Experiments involving nutrient enrichment of streams and rivers from 1960-1990 were rare, but most demonstrated some productivity benefits for juvenile salmonids. In the 1990s, application of stable isotope techniques for documenting the contribution of marine-derived nutrients to freshwater food webs showed that nutrients from salmon carcasses were an important contributor to aquatic plants and animals, as well as to riparian vegetation and scavenging wildlife. Since then, hatchery carcass distribution programs have become widespread, and more recently the development of carcass "analogs" from fish processing facilities have facilitated the distribution of marine-derived nutrients to remote locations.

In spite of the region's eagerness to embrace nutrient enhancement as a cost-effective restoration technique, very few studies have actually demonstrated that carcass or carcass analog placement results in the magnitude of productivity responses that have been observed in some of the Canadian sockeye lakes. Additionally, concerns have been expressed about the potential of carcass distribution programs to transmit fish diseases or persistent organic pollutants to streams, and to increase nutrient loading to downstream areas where additional nutrients are not wanted.

Matt Mesa of the U.S. Geological Survey's Columbia River Laboratory described a nutrient enhancement experiment in the Wind River watershed, Washington to evaluate the effects of nutrient enhancement on measures of stream and fish production. Carcass analogs made from Chinook salmon were placed into 500-m reaches of two streams and results compared for low level water chemistry, water quality, and periphyton, insect, and fish production between the two sections of streams that did or did not receive analog material.

The addition of carcass analogs in the summer and fall to two streams in the Wind River watershed significantly increased the growth of steelhead, produced mild to moderate increases in periphyton and insect production, and, for the most part, did not negatively impact water quality. The growth rates of fish in stream sections that received analogs were 10 – 150 times higher than those of fish in untreated control sections. Results indicated that seasonal additions of analogs can provide a temporary boost in productivity to streams that may be nutrient deficient due to low returns of salmonids; however, any benefits of the nutrient subsidy to these streams may be only short lived. Questions remain, for example, about whether short term increases in fish growth, such as those seen in treatment fish, actually translate into increased overwinter survival, more productive smolt outmigrations and, ultimately, increased adult returns.

Policy Implications for FWP Amendment Process

1. While popular with the public, and while some fertilizing projects in the Columbia River Basin have produced impressive gains in fish growth, the scientists recommended that fertilization should not be widely implemented until the impacts, such as potential water contamination, and benefits for fish, insects, and water quality are better understood. Carefully monitored field trials are warranted before the technique is implemented widely.

2. Questions remain about whether short term increases in fish growth due to nutrient enhancement, actually translate into increased overwinter survival, more productive smolt outmigrations and, ultimately, increased adult returns.

Roundtable Discussion Points

Tom Karier (Council Member, WA)
The region is looking for strategies that are cheaper, faster, and better. Nutrient enhancement seems to deliver in only 4 years what may take other habitat restoration techniques 15 years. With uncertainty, at what scale do we implement now? How fast can we expand this? Can we get information faster? Should we worry about water quality implications?

Pete Bisson (ISRP and presenter)
The studies suggest that we ought to move cautiously. We need more studies. For example, when you replace carcasses with carcass analogs, studies suggest this truncates benefits to the larger ecosystem. We don't know if it nutrient enhancement does really aid in overwinter survival and contributes to adult returns. We need to be aware of the limitations of each study.

Rich Carmichael (ODFW)
If you accelerate growth rate by 150%, it may have other negative effects on life cycle survival.

Matt Mesa (US Geological Survey and presenter)
These fish gorge for about a week, and the fish weight might be gaining stomach weight. But they are also looking at length.

Rick Williams (Facilitator)
Rick summarized the need for caution and study. When Idaho steelhead supplementation studies started, juveniles experienced rapid growth in the warmer waters of the Hagerman area (natal waters would have been colder and slowed growth). This resulted in large smolts at release and very high levels of residualization. Program now used chilled water to slow overwinter growth in juveniles prior to release in order to reduce residualization.

Pete Bisson (ISRP and presenter)
We might consider looking at nutrient enhancement through the IMWs; easier and more temporal.

Nancy Huntly (ISAB)
We also need to think about diversity. The management could be explored with varied treatments.

Gary James (Scientist, Umatilla Tribe)
These enhancement measures seem like life support. Isn't it better to get natural systems functioning? What would a natural distribution of dead fish (carcasses) look like in a watershed? What about small supplementation techniques in local areas?

Matt Mesa (US Geological Survey and presenter)
This is an underlying aspect of nutrient enhancement work – it is supposed to be temporary fix, not a long term solution. There have not been a lot of studies on carcass enhancement.

Pete Bisson (ISRP and presenter)
Similarly, it is not as effective as habitat improvement, because of short term fix. Effects are immediate and short term and do not stay in the system. Consequently, there are a lot of reasons to not implement program widely; variation in conditions could have big effect. We don't want to flatline several streams. It could change entire system dynamics.

John Piccinini (BPA)
At the Eugene, Oregon nutrient enhancement conference a few years ago, the water quality representatives got blasted by fish biologists for arbitrarily maintaining water quality standards that contradicted fish needs. Subsequently, Oregon created a water quality permit to plant carcasses under an agreement between ODEQ and ODFW specifying where application would be and the monitoring required. It's legal if permitted.

Alec Maule (USGS)
On a related topic, the issue of water contaminants wasn't explicitly covered in early recover plans, but toxics are now an important consideration in recovery planning. NOAA research shows that small changes in pesticide can result in susceptibility to predation.

Rick Williams (Facilitator)
The discussion immediately above reflects an increasing concern about the issue of imported contaminants. The studies indicate an immediate food web response and fish response; however, these responses are at small scales, and are not sustainable unless other mortality bottle necks in the system are addressed. What is proper spatial and temporal scale for additional research on nutrient enhancement?

Peter Paquet (Council staff)
The effect of nutrient loss above the dams was profound on resident fish, wildlife, and the terrestrial ecosystem. Many areas are now blocked to anadromous fish. The Council has responsibility to mitigate these effects too.

Pete Bisson (ISRP and presenter) and Matt Mesa (US Geological Survey and presenter)
Lamprey also made a significant contribution to the import of marine-derived nutrients. They have completely different dynamics than salmon. Lamprey are more absent from streams than salmon.

Dave Statler (Nez Perce Tribe)
Studies on loss of marine derived nutrients from salmon didn't include lamprey. These lamprey have higher per unit nutrient values than salmon. Need to focus on ecosystem restoration, not just salmon. Because of the losses in the Columbia, strategies directed at nutrients should be referred to as restoration rather than enhancement.

Will Conley (Yakima Tribe)
This brings us back to processes and the need to look at larger scales.

Matt Mesa (US Geological Survey and presenter)
Planting carcass analogs is only a restoration tool, not a panacea.

Bill Muir - (NOAA Fisheries)
We should identify where nutrient enhancement is needed. Where are the priority areas?

Session II: Mainstem

A. Mainstem Passage and Survival

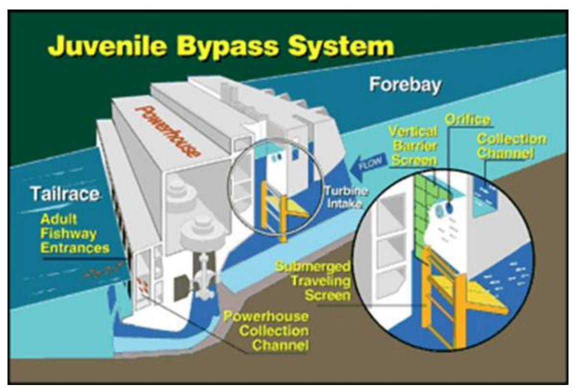
Status, Trends, Current management	Paul Wagner
Direct Dam and Reach Survival	Steve Smith
Adult Passage	Chris Peery
Removable Spillway Weirs: Survivals	Noah Adams / Gordon Axel
Snake River Chinook Survivals	Howard Schaller

B. Snake River Fall Chinook

Status, Trends, Current management	Paul Wagner
Productivity: Snake and Clearwater	Jay Hesse / Billy Connor
Life History Characteristics	Billy Connor
Flow/Spill and Juvenile Migration	Jerry McCann
Dworshak/Brownlee Operations	Greg Haller

One of the most expensive and technically difficult research and operations areas in the Columbia River Basin's attempts to mitigate fish and wildlife losses centers around fish passage at the mainstem dams. Most of the attention (and money) have been directed at achieving incremental improvements in juvenile fish passage at individual projects.

"The mainstem dams were not built for salmon passage; they were built for hydropower production," noted Paul Wagner, a biologist with the Hydropower Division of the National Marine Fisheries Service in Portland. "When a juvenile fish comes down the river, there's a passage hazard." Consequently, bypass systems were designed and retrofitted at the dams to improve passage survival for juvenile fish by routing fish away from the turbines and into a collection system for downstream barge transport or returning them to the river. Each year 60-90% of the juvenile fish are barged downriver. The worse the outmigration conditions (low water, high temperatures), the greater the percentage of fish that are transported downriver in barges. Other actions aimed at increasing juvenile fish passage efficiency include spilling water over dams or increasing the velocity of the river flow, or both. Fish ladders were built at the dams to assist adult fish returning upriver to spawn.

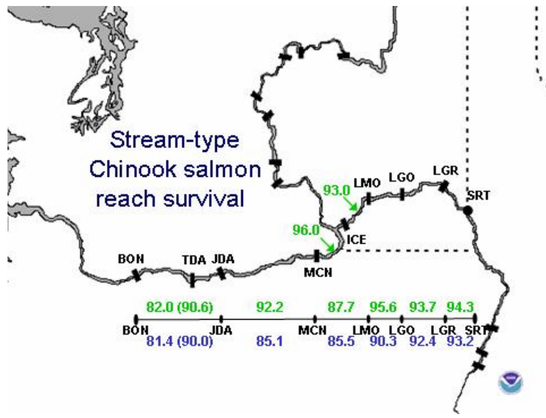


A. Mainstem Passage and Survival

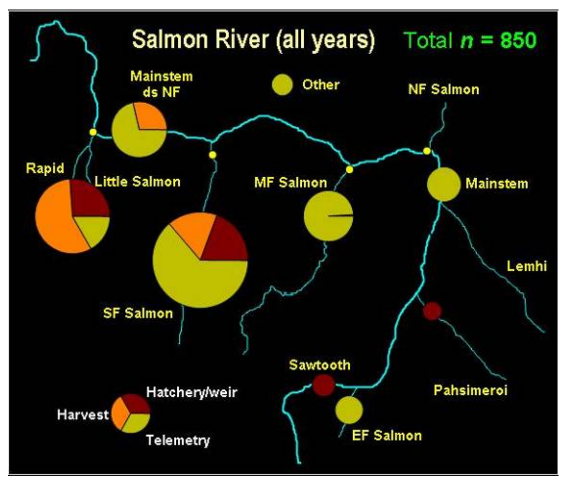
Scientific Assumptions in the Fish and Wildlife Program

Scientific assumptions in the Fish and Wildlife Program – its Scientific Principles – relate habitat diversity and complexity created by natural riverine processes, to the development and persistence of biological diversity, including salmonid productivity, resilience, and sustainability. Recognizing that the fish and wildlife program is a habitat-based program, assumptions specific to mainstem passage and survival focus on rebuilding naturally producing fish populations by reducing hydrosystem-induced mortality on fish during their juvenile outmigration and adult return migration. Ideally, fish passage (including transportation) should protect biological diversity across the range of species, stocks, and life-history types. Mainstem hydrosystem operations and fish passage efforts should be directed at re-establishing natural river processes and the protection and expansion of mainstem spawning and rearing habitat wherever possible.

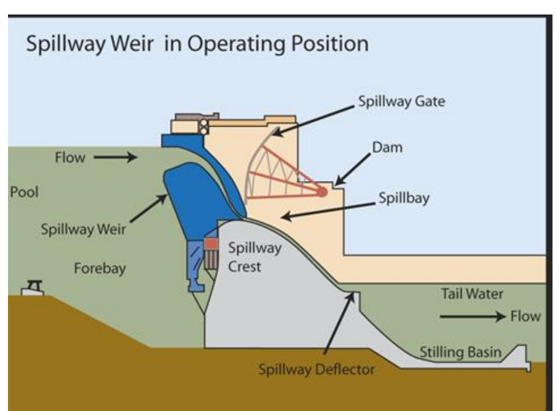
Summary of Current Scientific Findings



Bill Muir, a NOAA Fisheries biologist reported on the agency's juvenile fish survival research. He noted that for the entire hydropower system from the Snake River trap to the tailrace of Bonneville Dam, mean estimated survival in 2007 was 56.0% for Chinook salmon and 39.2% for steelhead. These estimates were only slightly lower than those from the high-flow year of 2006 and considerably higher than those from the similarly low-flow, high-temperature year of 2004. The research also showed that high survival through the hydropower system does not necessarily equate to high returns of adult fish. Other factors, such as conditions in the estuary and ocean, may affect whether the fish return as adults.



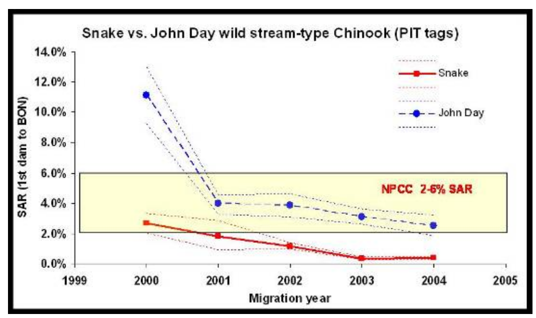
Chris Peery from the University of Idaho reported on telemetry studies on adult salmon and steelhead migration. Survival of adults past all of the dams can reach 95% under ideal conditions, and fall as low as 65% for stocks that are fished heavily. Survival also varies seasonally, annually, and by species. Spilling water over dams, which helps juvenile fish migrate downstream, can delay adult fish returning up the river, particularly when spill volumes are high. Additionally, a lower percentage of fish that were barged downriver as juveniles return as adults, compared to juvenile fish that were not barged. Poor passage conditions through the hydropower system, such as high water temperatures or fallback (when an adult fish passes a dam, but gets pushed back through the dam by the river current and has to climb the ladder again), can decrease survival further upstream, perhaps because the fish expend so much energy passing the dams.



Noah Adams from the US Geological Survey, Western Fisheries Research Center described a relatively new passage option for juvenile fish, known as surface-flow structures that show promise of improving fish survival while reducing the volume of water released over dam spillways. The agency studied fish passage through surface flow structures at Bonneville, McNary, and Lower Granite dams. These structures spill water, and juvenile fish, from the top 10 feet of the water column, compared to passage through spill gates that are typically 50-60 feet below the surface. Because most fish migrate in the top 10 feet or so, the surface-passage structures pass fish more efficiently in terms of water volume, particularly for juvenile steelhead but also for Chinook salmon. Fish survival through the flow structures was the same as or higher than passage through spill gates. Juvenile fish using the overflow spillway weir systems also passed dams more quickly.

Gordon Axel from NOAA Fisheries in Seattle described research on the recently installed removable spillway weir (RSW) at Ice Harbor Dam that evaluated behavior, passage distributions, and survival of yearling Chinook salmon, juvenile steelhead, and subyearling Chinook in 2006 and 2007, high-flow and low-flow years, respectively. Overall, passage distribution for 2006 through non-turbine routes was greater than 95% for yearling Chinook salmon and 98% for steelhead and subyearling Chinook salmon. In 2007, non-turbine passage routes accounted for greater than 92% of the yearling Chinook salmon and 98% of the steelhead. Overall, there was no difference in survival among species, project operation treatments, or flow years.

Howard Schaller of the U.S. Fish and Wildlife Service and Charlie Petrosky of the Idaho Department of Fish and Game reported on the survival of juvenile Snake River Chinook salmon and steelhead. Their research suggests that spring Chinook and steelhead from the Snake River survive only one-fourth to one-third as well as spring Chinook and steelhead from the lower Columbia River area. Water travel time appears to be the key. The hydropower system has slowed the migration rate for all salmon and steelhead, with those traveling the farthest being the most affected. Schaller hypothesized that there were influences of the hydropower system that manifest later. Survival decreases can be explained by what happens in the hydrosystem, modified by what happens in the ocean with temperature patterns and upwelling. All of these need to be taken into account when evaluating smolt-to-adult survival rates.



Consistency of Findings and FWP Assumptions

The various studies reported here represent good faith efforts by the fisheries research and management communities to understand the interaction of the hydrosystem with the behavior of fish during juvenile and adult migration periods. This information is needed in order to modify system configuration and operations in ways that protect and maintain biological and life history diversity in the remaining upriver salmon and steelhead stocks.

Policy Implications for FWP Amendment Process

The mainstem presentations and discussion contained many worthwhile points that should be considered during the upcoming amendment process. Juvenile passage rates at projects have improved, particularly with spill and use of RSWs, but no clear consensus emerged on how to optimize them at individual projects at this time. More research and experimentation will be needed, as juvenile survivals depend upon many complex inter-related factors. The policy implications below reflect this complexity.

The scientists offered policy advice for the Council based on results of the mainstem survival research, including:

1. Because fish survival varies with river and ocean conditions, and with whether juvenile fish are transported downriver in barges or migrate on their own, it will be difficult to meet specific survival targets established in policies.
2. Warm water and slow flows in the summer reduce survival of juvenile fish, so consider policies that address those problems.
3. Address the future of juvenile fish transportation, which has a measurable effect on fish survival.
4. Surface-flow passage devices are effective, but their effectiveness varies with varying levels of spill and flow. Combinations of flow and spill should be tested to determine maximum effectiveness without risking fish survival and water quality.
5. Study in-river migration conditions that maximize survival in light of river travel time and annual conditions in the estuary and ocean.
6. Study the survival benefit of barge transportation for subyearling fall Chinook salmon from the Snake River in comparison to the survival benefit of summer spills at the Snake River dams to aid the downstream migration of these fish. One difficulty with this research is that juvenile fall Chinook have not been available from Snake River hatcheries for this purpose in recent years because the research has a lower priority than other uses for those fish. It appears that these "test fish," which were not available in 2006, also will not be available in 2007, unless there is a policy change that would give the research higher priority.
7. Consider policies that fine-tune spill levels, flow, and fish bypass structures at each dam, as the research suggests that a one-size-fits-all approach won't work.
8. Consider the cost-effectiveness of fish and wildlife program expenditures for artificial production of fish and hydrosystem passage improvements, which collectively total approximately 80 percent of the annual program budget. Have these expenditures reached the point of diminishing returns, and might some of that funding be directed more effectively to other parts of the program such as habitat improvements upriver or in the estuary?

Roundtable Discussion Points

Audience observations

There is not a lot of correlation between river survival and smolt to adult survival rates (SARs). Most of the mortality occurs in the ocean. SARs are 2% or below (i.e., below replacement), so variation of in-river survival gets thrown in with ocean survival. How would you explain difference between John Day stock performance and Snake River?

Howard Schaller (US Fish and Wildlife Service)

You can't explain the overall survival patterns by what you see in the river, but you can with a combination of ocean, climate, spring survival, in river. There are influences on the system that manifest themselves later. For Snake River stocks, 71% of survival is explained by conditions in first year of life in ocean.

Steve Smith (NOAA Fisheries and presenter)
If conditions in hydro system correlated with first year of survival, how does it relate to SAR?

Howard Schaller (US Fish and Wildlife Service)
Direct survival is just one component compared to survival in first year of ocean residency.

Tom Karier (Council Member, WA)
Tom asked each of the presenters to respond to the following questions: What are policy implications of RSWs (Removable Spillway Weirs)? Are they basically good?

John Williams (NOAA Fisheries)
There is no direct correlation between RSW passage and SARs. What are the policy implications of setting hydrosystem passage and survival target levels?

Chris Peery (Scientist and presenter, University of Idaho)
Adult migration and survival issues. Survival is relatively good through the system. Every adult returning salmon or steelhead is precious. Temperature patterns need to be mitigated in late summer and fall. Also should look at straying associated with transportation; what is the actual benefit of transportation?

Noah Adams (scientist and presenter, USGS)
Removable Spillway Weirs (RSWs) are powerful tools. The question is how do you maximize them with training spill?

Gordon Axel (NOAA Fisheries and presenter)
The take home message from the Ice Harbor research is that you need to fine-tune your spill operations. This was done by finding the optimal amount of water spilled for fish passage guidance and efficiency.

Howard Schaller (US Fish and Wildlife Service)
The take home message is to take a more holistic approach. What types of in-river conditions lead to higher survival considering direct and indirect effects, and near-shore and ocean conditions?

Rick Williams (Facilitator)
The policy message is that each dam is its own individual. Each dam needs to be fine tuned for optimal survival. The GAO (General Accounting Office) reports from 1992 and 2002 showed that 40% of funding goes to support artificial production and another 40% to mainstem passage. Have we reached a point yet of diminishing returns on future investments?

Steve Smith (NOAA Fisheries and presenter)
Project by project average survival over dams is around 90%. About half the mortality occurs at the dams and half in the reservoirs.

Russ Kiefer (Idaho Fish and Game)
In 2001, when we had a Power Emergency, in-river survival declined. Also in 2001, we saw that the typical relationship of in-river fish surviving better than transported fish once below Bonneville Dam was reversed. This is probably due to latent mortality from low flows and no spill at the dams. RSWs should be operated in concert with spill as a potential means to reduce latent mortality.

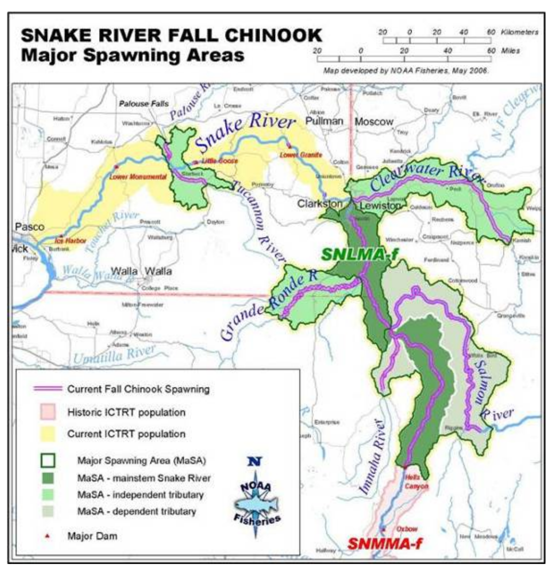
B. Snake River Fall Chinook

This session of the Science-Policy Exchange focused on emerging knowledge about Snake River Fall Chinook. Issues of concern have to do with understanding fall Chinook life history, which contains both yearling and subyearling outmigrants and the relationship of these life histories to environmental conditions within the hydrosystem's series of linked reservoirs as well as to the water management operations of the hydrosystem. These relationships are among the most complex and difficult to deal with in the context of hydrosystem operations, particularly for the fall Chinook subyearling life history where the typical summertime conditions of lower flows and higher water temperatures make migration conditions difficult and survival problematic.

A wide range of management actions has been implemented to improve the passage and survival of salmon and steelhead populations migrating through the mainstem Columbia and Snake River hydropower projects. These actions include flow augmentation, spill at mainstem dams, installation of juvenile bypass systems, transportation of juvenile fish, modifications of spillways for surface passage, and improvements in adult fish passage. Presenters provided an overview of these mainstem passage efforts and their relative success on fall Chinook populations.

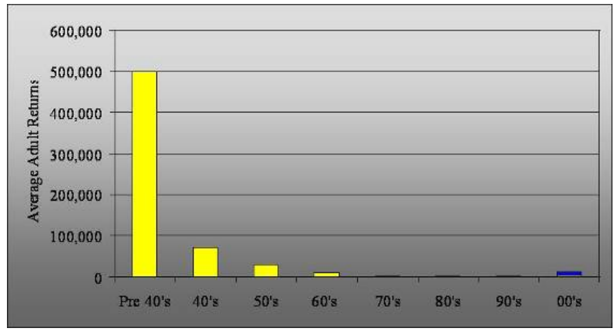
Summary of Current Scientific Findings

Fall Chinook management centers around protecting and enhancing life history diversity, expanding current distribution balanced with the constraints of summer flow management volumes. Draft limits on flow augmentation volumes and changes in spill levels have been proposed and are currently being investigated. The 2004 BiOp required investigation as to whether survival would increase with more spill, recognizing that flow augmentation helped fish migrating under summer conditions. There is a negative correlation between temperature and survival (higher temperatures = lower survival), consequently most Snake River fish are transported.



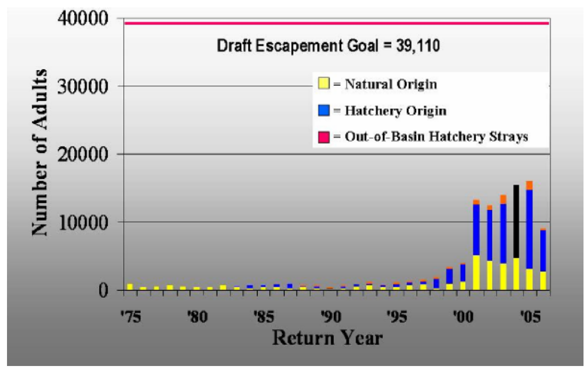
Jay Hesse (Nez Perce Tribe) and Billy Connor (US Fish and Wildlife Service) reported that Snake River fall Chinook salmon abundance and productivity have been and continue to be influenced by construction and operation of hydroelectric dams and hatcheries, among other natural and management factors. They summarized four areas related to productivity: 1) adult abundance; 2) hatchery programs; 3) management actions; and 4) remaining critical uncertainties.

Historical abundance of fall Chinook salmon in the Snake River Basin was 70,000-100,000 fish annually; however, from the mid 70's to late 90's return levels have averaged less than 1,000 and were as low as 100 natural-origin fish. Much of this decline was directly attributable to blocked access or inundation of spawning habitat. Hatchery programs were developed in the past 20 years to mitigate for some of this lost productivity. Hatchery programs were modified and expanded in the mid 90's to incorporate supplementation objectives (release of hatchery juveniles in natural production areas) as a result of litigation by the Columbia River treaty tribes. Recent returns, including hatchery origin fish, have been 10,000 to 15,000 (2,500 natural origin adults). Distribution of spawners within the accessible habitat has started to re-colonize areas in the Salmon River, Imnaha River, Grande Ronde subbasin, and South Fork Clearwater River, but much of the historical habitat remains block or underutilized.



Fall Chinook returns to Snake Basin

Available information on Fall Chinook productivity is far from comprehensive, with many technical discrepancies. Hatchery releases upstream of Lower Granite Dam have increased the abundance of spawners in natal habitat, with assumed contribution to increased production. While increases in abundance and productivity have occurred, the extent to which those improvements in overall life-cycle survival effects on fall Chinook salmon will be maintained and can be attributed to recent changes in management vs. merely reflective of improvements in ocean productivity is uncertain. Hesse noted that natural-origin adult abundance was near the identified delisting criteria; however, total abundance of Fall Chinook is well below historical levels and current management goals.

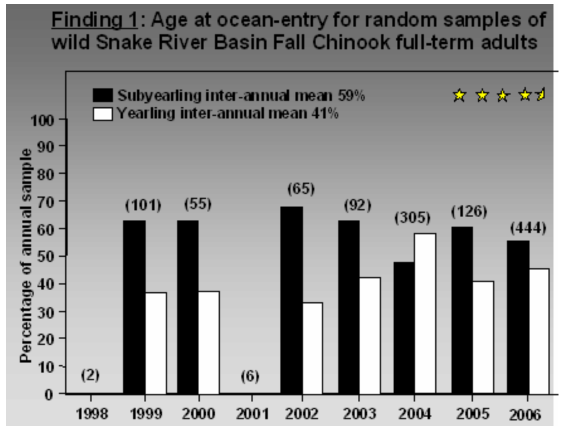


Harvest of Snake River fall Chinook salmon still occurs in ocean and mainstem Columbia River fisheries; however, substantial reductions in state and tribal fisheries were implemented in 1993 and continue today. Several critical uncertainties still exists relative to the short-term and long-term productivity of Snake River fall Chinook, including: relative reproductive success of supplementation and natural origin adults; long-term persistence of an ESU with a single extant population spatial structure and diversity; estimates of juvenile abundance/production; factors influencing and magnitude of carrying capacity.

Billy Connor (US Fish and Wildlife Service) reported that prior to 2002, it was largely assumed that juvenile Snake River Basin fall Chinook salmon migrated seaward during summer and fall and entered the ocean as subyearlings. Research published in 2002 and 2005 provided the first peer-reviewed evidence for yearling migration and ocean entry, respectively. It has been difficult to characterize, understand, and incorporate this alternative juvenile life history into management and research paradigms.

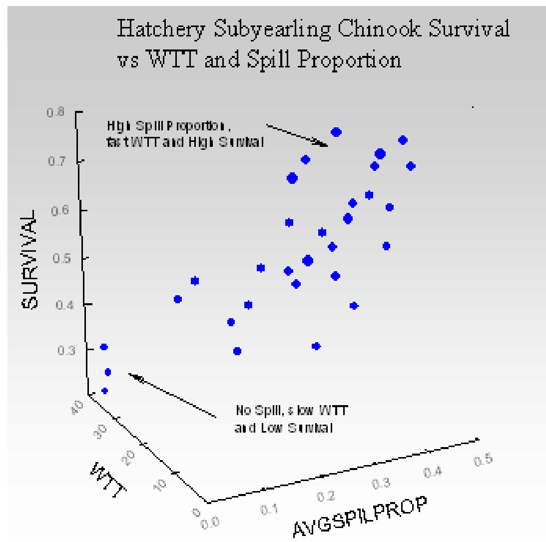
Our research goal has been to: (1) describe age at ocean-entry for the Snake River Basin population of full-term wild fall Chinook adults; (2) describe age-at-ocean entry for transported subyearlings; (3) describe age-at-ocean entry for in-river migrants; and (4) summarize the limited information on smolt-to-adult return rates (SARs).

Both subyearling and yearling migrants made substantial contributions to the return of full-term wild adults. Subyearling and yearling ocean entry was evident in full-term adults from summer and fall transport groups as well as in-river migrating groups. The tendency to become a yearling ocean entrant increased as the migration season progressed. There was also an increase in SARs as the migration season progressed.



They concluded that: (1) during years when summer spill was not fully implemented at Snake River dams, both subyearling and yearling migrants made substantial contributions to adult returns regardless of how they reached the sea; (2) the relatively high SARs for late migrants destined to become yearling ocean entrants likely compensated for a high rate of mortality during early rearing; (3) the relatively low SAR for early migrants destined to become subyearling ocean entrants may or may not have been a function of in-river conditions (i.e., no summer spill). Determining the effects of summer spill on SARs of in-river migrating subyearling ocean entrants is an important area for future research.

Jerry McCann (Fish Passage Center) described the migration characteristics, survival, and travel time of subyearling fall Chinook using PIT tag data from hatchery/production subyearling fall Chinook releases above Lower Granite Dam to McNary Dam. Survival and travel time were estimated, as well as downstream timing past Little Goose, Lower Monumental, Ice Harbor, and McNary dams. Timing data was used to estimate the average in-river conditions the fish experienced passing through the river reach; such as water transit time, discharge, spill percentage and water temperatures at the dams and reservoirs. The relationship between survival and travel time through the reach Lower Granite Dam tailwater to McNary Dam tailwater was compared to in-river conditions in a series of bivariate weighted regressions. Generally, survival was highest during periods of high flow and spill and cooler temperatures. Court ordered summer spill appeared to improve survival in recent years when flows were lower and temperatures warmed, compared to prior years when spill ended June 20.



Greg Haller of the Nez Perce Tribe reported on efforts to coordinate the warmer water releases from the Hells Canyon Complex of dam with the coldwater releases from Dworshak Dam on the North Fork of the Clearwater to best benefit fall Chinook survival and growth. Dworshak is drafted heavily in the summer to cool the Lower Snake River. There are different life histories between Clearwater and Lower Snake Fish that need to be balanced to assist migration of Lower Snake fish that migrate earlier and to not stunt the growth of Clearwater fish. Dworshak Dam and a large part of the reservoir are located within the boundaries of the Nez Perce

Reservation. Each summer, from July through September, Dworshak is drafted 80 feet from full to provide up to 1.2 million acre-feet of flow augmentation to benefit juvenile fall Chinook emigrating through lower Snake Reservoirs. This results in impacts local recreational use of Dworshak Reservoir where drawdown of the reservoir is especially unpopular if it occurs before July 4th.

Policy Implications for FWP Amendment Process

The scientists offered policy advice for the Council based on results of the mainstem survival research, including:

1. Warm water and slow flows in the summer reduce survival of juvenile fish, so consider policies that address those problems. Balance flow and temperature releases from Dworshak and Hells Canyon complex.
2. Consider policies that fine-tune spill, flow, and fish bypass structures at each dam, as the research suggests that a one-size-fits-all approach won't work.
3. Study in-river migration conditions that maximize survival in light of river travel time and conditions in the estuary and ocean.
4. Study the survival benefit of barge transportation for subyearling fall Chinook salmon from the Snake River in comparison to the survival benefit of summer flows and spills at the Snake River dams to aid the downstream migration of these fish. One difficulty with this research is that juvenile fall Chinook have not been available from Snake River hatcheries for this purpose in recent years because the research has a lower priority than other uses for those fish. It appears that these "test fish," which were not available in 2006, also will not be available in 2007, unless there is a policy change that would give the research higher priority.

Roundtable Discussion Points

Audience Question
Oxbow hatchery has the responsibility of producing 4 million Chinook without an adult return objective. Isn't this a policy issue?

Jay Hesse (Scientist and presenter, Nez Perce Tribe)
Idaho Power has an obligation to produce 1million smolts.

Nancy Huntly (ISAB)
Jay's slide showed natural fish increasing without meeting number of hatchery fish releases. If you are doing well with natural numbers, do you risk that success by trying to push artificial production?

Jay Hesse (Scientist and presenter, Nez Perce Tribe)
The dip in production shown in our graph was a result of low returns and a decision to not include strays in the broodstock. A very significant policy question is the mitigation responsibility for Lyons Ferry Hatchery. So you have a difference of goals at play between ESA vs. hydro mitigation.

Q: Subyearling transport and survival data were not available for 2007; will they be available in 2008?

Billy Connor (Scientist and presenter, USFWS)
It doesn't look like it

Tony Nigro (ODFW)
US v. Oregon parties are talking about the 2008 transportation studies; one of the things they are talking about is reserving enough fish for the transport studies.

Eric Loudenslager (ISRP)
How were the productivity measures calculated?

Jay Hesse (Scientist and presenter, Nez Perce Tribe)
The average age class structure estimates were consistent with those done by the TRTs,

Steve Yundt (Idaho Department of Fish and Game)
Does Lower Snake escapement goal of 40,000 include harvest? These goals are considered 80% harvest goals.

David Welch - (scientist)
What about evaluating juvenile fish survival per day, by time?

Jay Hesse (Scientist and presenter, Nez Perce Tribe)
An apples-to-apples comparison was important; comparing between years did not meet this criteria. Billy raised the issue of data starting at different times. This comes into play looking at full life cycle performance, where they can build consistency into play.

Billy Connor (Scientist and presenter, USFWS)
The technology to study the fish is limiting.

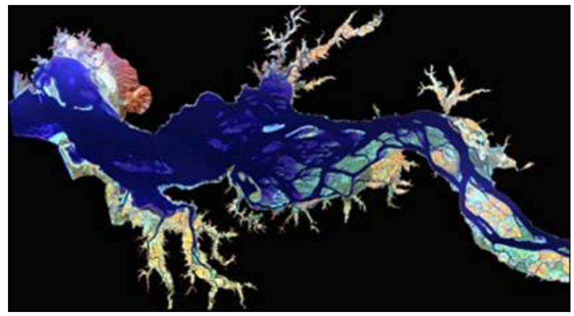
John Sneava, (WDFW)
What about scale analysis on adults? One thing that has changed that would affect scale analysis is that fish are now released at a larger size. Two implications - the pattern is that hatchery fish are beginning to look more like downstream patterns, and more strays. From a policy perspective, it would be good to look at genetics of strays. This might happen and cause an impact on wild ocean-type life history. Linking to the transportation system, you could maximize scale collection.

Bob Heinith (CRITFC)
The Fish and Wildlife Program is supposed to protect all fish and wildlife. The lamprey are disappearing and the new amendment process should maintain a multi-species focus. The program also needs to protect non-salmonids. Lamprey recently exhibited the lowest counts ever seen at Bonneville; only 20-30 above Bonneville. Really needs to be addressed in amendment process

Dave Statler - (Nez Perce Tribe)
The amendment process needs to consider how management actions for one species, such as salmon, affect another species, such as lamprey.

Session III: Estuary

Overview	Colin Levings
Survival through the Estuary	John Ferguson/ Don Lyons
Life Histories, Habitats, Food Webs	Dan Bottom
Lower Columbia River Estuary Partnership	Deb Marriott



One of the many scientific uncertainties of the salmon life cycle is how well juvenile fish survive their transit though the lower Columbia River from Bonneville Dam to the mouth of the river, a distance of about 145 miles that includes the Columbia River estuary. Saltwater and freshwater mix through almost that entire length typically with denser salt water below and freshwater on top. Present habitat quality and composition differ dramatically from historical conditions, which raise questions about juvenile salmon use of estuarine habitats and survival during their transition into the marine environment.

Since Euro-Americans began to settle in the estuary in the mid-1800s, the amount of salmon habitat has declined by 50 percent on average, and in some areas by as much as 75 percent. Deborah Marriott, Director of the Lower Columbia River Estuary Partnership (LCREP) described ongoing efforts to restore habitat and gain a better understanding of the impacts of contaminants in the lower river and estuary. These efforts have been ongoing since 1999 and have been funded by state and federal agencies, much of it through the Council's Fish and Wildlife Program. More than 122 projects have been undertaken and nearly 13,000 acres of habitat restored. LCREP is also mapping wetland loss in the estuary. The use of satellite imagery is helpful in the classification process. Projects have included land acquisitions; tide gate removal and retrofits; breaching dikes and berms; removing pile dikes; revegetating habitat areas; and assessing wetland habitats. High priority areas for restoration include culverts, dikes, and other areas with high potential to bring water back into areas that were previously flooding with change in tide.

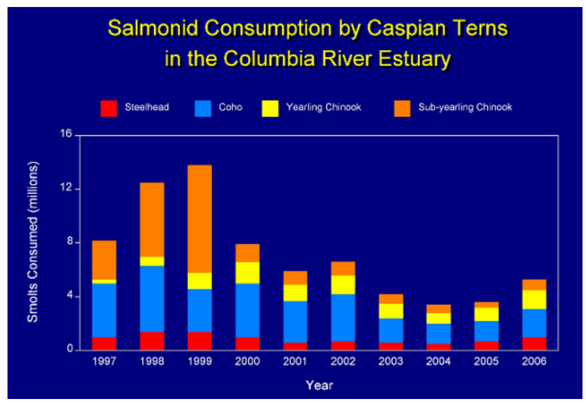
Scientific Assumptions about the Estuary in the Fish and Wildlife Program

The Council's Fish and Wildlife Program is largely a habitat-based program that focuses on rebuilding naturally producing fish populations by protecting and restoring habitats, including anadromous fish migration corridors. Consequently, scientific assumptions about the estuary are built around the habitat diversity-salmonid productivity conceptual foundation already discussed as embodied in the FWP's Scientific Principles.

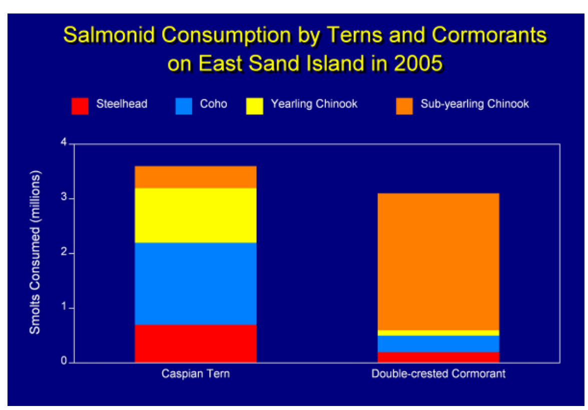
Summary of Current Scientific Findings

John Ferguson of the National Marine Fisheries Service's Northwest Fisheries Science Center in Seattle described research conducted in 2005 and 2006 that showed the average survival from Bonneville Dam to the mouth of the river as 69 percent for yearling Chinook salmon and 50 percent for subyearling Chinook. One possible reason for the lower survival of subyearling Chinook was predation by northern pikeminnow, which are prevalent upstream from Bonneville and may be more abundant downstream of the dam than previously believed.

The focus of the research was to determine what habitats the fish select in the estuary, how long they remain in those places and, if they die between detection points, how they died. One interesting observation from the research is that survival of juvenile salmon and steelhead is about the same between Bonneville Dam and the estuary as it is between Lower Granite and Bonneville dams. Between Lower Granite and Bonneville, the fish have to pass eight dams; between Bonneville and the estuary there are no dams. Survival of yearling Chinook between Lower Granite and Bonneville dams in 2005 was 58 percent, and 64 percent in 2006. Between Bonneville Dam and the estuary, survival was 69 percent in 2005 and 68 percent in 2006.



Donald Lyons, a Ph.D. candidate at Oregon State University who has been researching predation by birds in the estuary, noted that predation on juvenile salmon and steelhead by Caspian terns and double-breasted cormorants is a continuing and, for some species, a growing problem. The successful relocation of the large Caspian tern nesting colony in the Columbia River estuary from Rice Island downstream to East Sand Island reduced predation by terns on salmon and steelhead in the Rice Island area. The distance from Rice Island, which is upriver from Astoria, to East Sand Island, which is closer to the mouth of the river, is about nine miles. Before the re-location (1997-1999), terns consumed an estimated 4.8-10.3% of all juvenile Chinook and coho salmon, and steelhead, in the estuary. Between 2000 and 2006, the number declined to 3.2-5.5%. By further dispersing the terns, predation might drop to about 2%. This could be accomplished by making potential nesting sites less attractive to the birds and encouraging them to nest away from the Columbia estuary. Terns prefer to nest on open sand, so planting beach grasses or erecting visual barriers – fences, for example – can effectively discourage nesting.



Predation by double-breasted cormorants, however, is more problematic, as these birds will nest practically anywhere and, unlike terns, can dive into the water to chase prey. Only 100-200 cormorants were in the estuary in 1980, but today the number is more than 28,000. While the tern population appears to have stabilized at about 18,000 birds, the cormorant population is increasing. Reasons for this are not clear, but it may have to do with several factors – available habitat, abundant prey, and the ban on pesticides such as DDT that once contaminated Columbia

River water and affected egg growth of cormorants and other birds in the estuary. Cormorants nest and feed in the estuary at about the same time of year as terns, from late spring through late summer.

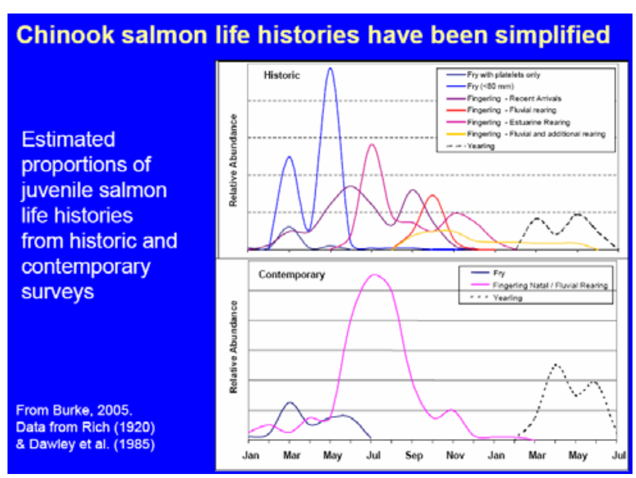
Researchers draw several conclusions from the recent studies of predation on salmon and steelhead by terns and cormorants:

1. Tern relocation to East Sand Island benefited sub-yearling Chinook and apparently coho
2. Planned dispersal of terns away from estuary provides some benefit for steelhead and coho, but less for yearling (spring) Chinook and little for sub-yearling (fall) Chinook
3. Preliminary results suggest predation by cormorants is about the same as predation by terns except for yearling Chinook salmon, which might be higher.

Daniel Bottom of the Northwest Fisheries Science Center office in Newport, Oregon noted that throughout the past century, two competing assumptions have directed management efforts in the Columbia River estuary on behalf of salmon: 1) the estuary is irrelevant to conservation because fresh water conditions limit salmon production; and 2) the estuary is a threat to juvenile salmon because bird and mammal predators are concentrated in the narrow lower-river corridor. These ideas have ignored the estuary's role as a productive nursery ground and transitional habitat for salmon stocks throughout the Columbia River Basin.

The Columbia River estuary contributes to salmon life history diversity by providing habitat opportunities for juveniles with subyearling-migrant life histories. Small subyearling Chinook salmon seek shallow water rearing habitats and occupy a diversity of emergent, shrub, and forested wetlands throughout the tidal freshwater and brackish areas of the Columbia River estuary. Many estuarine-rearing juveniles feed in wetland channels, grow on average 0.5 mm per day, and reside in the estuary for weeks or months before entering the ocean.

Juvenile salmon need time to adapt to salt water and the estuary provides the place for the gradual transition between freshwater and saltwater environments. The estuary also provides productive feeding grounds because organic matter from upriver is trapped there and forms the base of one of the most productive food chains in the world. Small fish find refugia at the surface in off-channel areas, in contrast to the popular view that the estuary is a "killing field." Chinook are the most estuarine dependent, chum rear in the estuary, and coho reside in the tidal areas. Some fish move through the estuary rather quickly while others reside up to a year. Those that don't leave until late summer represent 90% of adults that return suggesting that more time in the estuary leads to higher survival rates. The fact that the different runs have different life history traits provides resilience to the stock and enhances genetic diversity. Losing the diversity of traits in the population decreases the ability of the stock to adapt and to retain resilience and flexibility.



Recent estuarine surveys suggest that life history diversity among subyearling Chinook salmon has declined since early in the twentieth century and could limit the resilience of contemporary populations to changing environmental conditions. Numerous changes upriver (e.g., hatchery programs, population losses, flow regulation) and within the estuary (e.g., wetland habitat losses, increased water temperatures) may have contributed to the apparent reduction in life history variation. Loss of tidal wetlands could further limit the capacity of estuarine food webs to support juvenile salmon.

Energy flow to salmon is derived from wetland detritus, and juveniles throughout the estuary feed on insect prey that is produced in wetland habitats. Although sources of wetland detritus have declined during the last century, contemporary salmon food webs still rely disproportionately on wetland-derived prey. All Columbia Basin ESUs are represented in estuarine habitats, and a diversity of genetic stock groups, including interior summer/fall Chinook stocks, rear in tidal wetland habitats of all types. Recovery of Columbia River salmon will require that sufficient habitat opportunity is provided in the estuary to accommodate the full complement of stocks and life history types in the basin. The question remains whether lost life history diversity can be restored. A restoration project on the Salmon River on the Oregon coast where 75% of the historic wetlands were restored via dike removal saw fish moving into restored wetland very quickly. This suggests that diverse populations will have the resilience to recover as habitat is restored. The estuary is critical habitat that requires study and recovery.

Among the principal concerns in the estuary for salmon recovery programs are loss of peripheral wetland and tidal floodplain habitats; effects of hatchery programs and flow regulation on patterns of estuarine migration, residency, and habitat use; and the risk of increasing water temperatures on summer and fall rearing opportunities for young salmon. A message for policy-makers, was that recovery of salmon and steelhead will require that sufficient habitat in the estuary is available to support salmon that arrive from throughout the Columbia River Basin.

Consistency of Findings and FWP Assumptions

Current research directions and habitat improvements funded through the Lower Columbia River Estuary partnership directly reflect the Council's Scientific Principles and the assumptions about the positive relationship between habitat, salmonid life history diversity, and sustainable production.

Policy Implications for FWP Amendment Process

The scientists who presented their estuary research had the following recommendations for policy-makers:

1. Because fish from throughout the Columbia River Basin use estuary habitat for rearing before entering the ocean – and for varying amounts of time – river management should not be based on the assumption that there is an optimum time of residence in the estuary. One size will not fit all.
2. Survival of wild fish should drive management decisions. The freshwater tidal reach is an unknown and an obvious research priority. Intensively monitored watersheds might include estuary sites to better understand how fish use these habitats. Quantitative goals should be considered for habitat restoration.
3. Survival in the estuary is lower than previously believed, and it's not that much different than survival through the hydropower system. Predation by birds in the estuary might be reduced if barged smolts were released downstream from Astoria, although this might also affect their survival, if rearing and physiological transition time in the mixed saltwater and freshwater environment of the estuary is needed for their maturation and survival.

4. Policies should connect the (upriver) hydropower system to the (lower river) estuary, synthesizing available scientific knowledge in order to direct future research and policy-making. For example, some Snake River fall Chinook are spending up to a year in the estuary, but it is not known where. This knowledge could inform policy decisions on hydropower operations that influence salmon travel time and habitat conditions in the estuary.
5. Rather than focusing policies on quantifying increases and decreases in fish mortality, consider focusing policies on creating more of what the fish need – more acres of salt marsh, for example. Dan Bottom summed this up well in noting, "We are beginning to shift our research and policy focus from survival from dam to dam to understanding what it all means in the end to fish coming back. The estuary is one of many alternative rearing environments that salmon have adapted to use, and we need to preserve it as part of the continuum. In the policy arena, we need to look at the estuary as a critical part of the salmon life cycle."

Roundtable Discussion Points

Tom Karier (Council member, WA)
How do we know when we get to salmon recovery and how far along the path are we? The science/policy exchange was called exchange for a reason. Ocean and estuary have come into their own in the program over the past decade. The assumption is that all the anadromous fish go through the estuary, so this is an important area for improvement of fish survival.

Stuart Hurlbert (ISAB)
How do you disperse the Caspian terns from areas where they are not wanted?

Don Lyon (OSU PhD candidate and presenter)
We use decoys in habitat areas along their migratory path as the "pull." We also "push" by reducing scarified area that they require for nesting habitat.

Tom Karier (Council member, WA)
What management efforts are being done for cormorants?

Don Lyon (OSU PhD candidate and presenter)
Cormorants can nest in many areas and aren't as group oriented as terns, so they are harder to relocate. Management options are narrower.

Dan Bottom (NOAA Fisheries and presenter)
The research conducted in the Columbia River estuary has been consistent with research in other West coast estuaries. Defining how much salt marsh we need might not be a fruitful exercise. There's so much opportunity. Survival estimates aren't the approach they are taking; they are trying to find what salmon need and provide that.

Barging fish offshore? But fish with access to estuary had better survival. The basin is progressing from looking at from one dam to one dam to looking at entire life history. The estuary is just one part of the continuum.

Rick Williams (Facilitator)
We need to look at the upper two thirds of estuary in more detail and improve our understanding of stock specific use of habitat including tributary deltas. Greater efforts need to be made to link management of the estuary to the operation of the hydroelectric system.

Dan Bottom (NOAA Fisheries and presenter)
All restoration isn't equal. The best thing you can do is remove the tidegates - this is at the eco-process level. But this would flood areas, farm lands. What are the compensatory actions for farmers and other resource users. The CALFED program might have examples of restoration strategies.

Rick Williams (Facilitator)
They do they have secondary dikes in the Sacramento River in off channel areas. In higher water years, these habitats are flooded and fish get priority; while in low water years farmers can use for agricultural production.

Deb Marriott (LCREP)
A high percentage of projects funded in the Lower Columbia estuary partnership are tidegate removals. The partnership is presently trying to determine the right tools for more urban areas.

David Welch (Scientist)
If we manage to return the estuary to functioning for salmon, can you measure improvements in survival? Likely no, but in a place like the Salmon River Estuary the area was small enough and action large enough, that researchers could detect the signal. Benefits to life history diversity was good.

Rick Williams (Facilitator)
These kind of questions call for consideration of an IMW-type approach (Intensively Monitored Watershed) to learning in the Columbia River estuary, where a longer-term coordinated commitment to management actions and monitoring may pay dividends in tying juvenile salmonid survival, life history, and habitat together with operations of the hydrosystem.

Session IV: Ocean and Plume

A. Coastal and Ocean Ecosystems

Overview	Bill Pearcy
Ocean-entry timing / Plume research	Ed Casillas
Productivity, variability, and PDO	Ed Casillas

B. Northeast Pacific basin

Overview	Kate Myers
Distribution / Migration	Kate Myers
- *Coded wire tags*	
- *Genetic studies*	
- *POST system data*	
Review of comprehensive tagging studies	Kate Myers

Coastal and Ocean Ecosystems

Prior to the 1970s, scientists generally believed that the Pacific Ocean had an unlimited capacity to support salmon and steelhead, but in that decade major changes in ocean temperatures caused a radical re-thinking of the old assumption and spurred research that continues to this day. In 1976-77, an influx of warm water from the south overrode cool water near the ocean surface, disrupting the cool-water upwelling that supports the growth of food organisms for juvenile salmon and steelhead. Then in 1982-83, a strong El Nino event further disrupted the ocean environment in a similar fashion. The result was a kind of desert for salmon and steelhead off the coasts of Oregon and Washington. As well, the warmer water attracted predator fish to migrate north from the ocean off California and Mexico. Research over the last 20 years has resulted in a better understanding of the warm-water phenomenon -- not its cause, but its impacts and timing. The warm-water appears to alternate with cold-water in decades-long cycles. Warm-water cycles are bad for fish from the Columbia River Basin, and cold-water cycles are good in terms of feeding conditions in the ocean.

In addition to impacts from climate changes, predation by sea birds including sooty shearwaters and common murres also is a problem for juvenile salmon and steelhead, particularly in the area where the freshwater plume from the river merges with saltwater beyond the mouth of the river. Disease, perhaps exacerbated by warmer waters, is another problem, and one that needs further research.

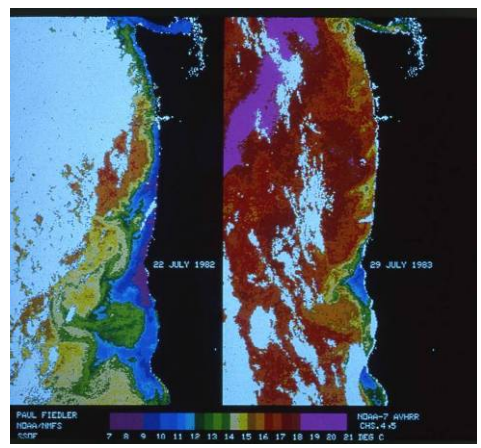
Scientific Assumptions about the Ocean in the Fish and Wildlife Program

Assumptions in the Council's Fish and Wildlife program about the ocean are general, and unlike the remainder of the program, are not habitat-based. Assumptions about ocean function and salmon survival are based on several general strategies. Primary among these is the need to identify the effects of ocean conditions on anadromous fish and use this information to evaluate and adjust inland actions. Secondary strategies include managing for temporal and spatial variation in ocean conditions and the need to distinguish ocean effects from inland effects.

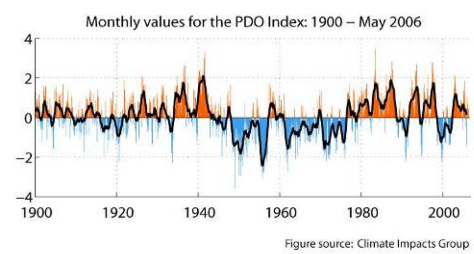
Summary of Current Scientific Findings

William Pearcy, an emeritus professor of marine biology at Oregon State University summarized the relationship between ocean conditions and salmon survival by noting that survival of juvenile salmon and the number of adult salmon that return to spawn often are well-correlated with the intensity and timing of coastal upwelling. Much of the mortality on salmon and steelhead during their life cycle occurs in the ocean and growth and survival vary depending on conditions that prevail during early life within a year, among years, and among decades. Hypothesized mechanisms linking survival to ocean conditions during the first critical year of ocean life include ocean productivity, prey availability and growth, and predation.

Dr. Pearcy also discussed the variability of ocean conditions and elaborated on the El Nino, Pacific Decadal Oscillation (PDO), and coastal upwelling events. The 1983 El Nino was the big wakeup call for salmon biologists, that ocean variability was significant. Subtropical predatory fish off the mouth of the Columbia and clear up into the Alaskan Gulf. Similarly, our understanding of longer-term cycles in variability and their effects on salmon survival increased over the last several decades. Ocean temperatures also appear to vary over decadal scales that dramatically affect salmon abundance in the Columbia River.

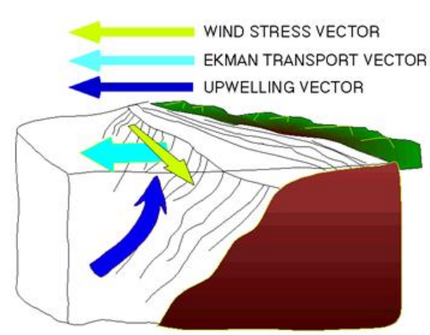


Ocean temps (1983): WA, OR, CA



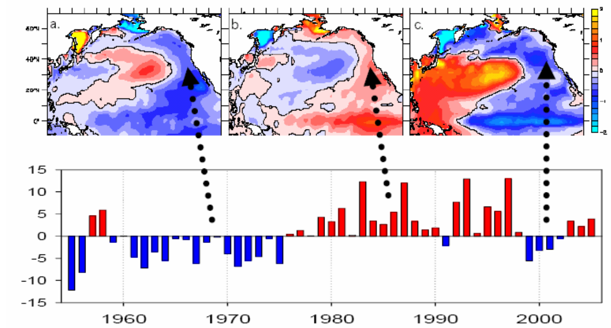
The Pacific Decadal Oscillation (PDO) appears to have two phases; a cool one where salmon production off the Pacific Northwest Coast is high, and a warm phase, where survival of Columbia River salmon in the marine environment is low.

Coastal upwelling occurs in the summer off the Oregon Coast. Water dips as it goes inshore, creating a vacuum. The vacuum is filled by cool, nutrient-rich deep water. If fish arrive at the time of upwelling, their chances for growth and survival are much greater. For example, there is good correlation of upwelling for the OPI coho and Chinook indices. If juveniles arrive after water temperature stratification occurs (as happens during warm PDO cycles, then there is high juvenile mortality.

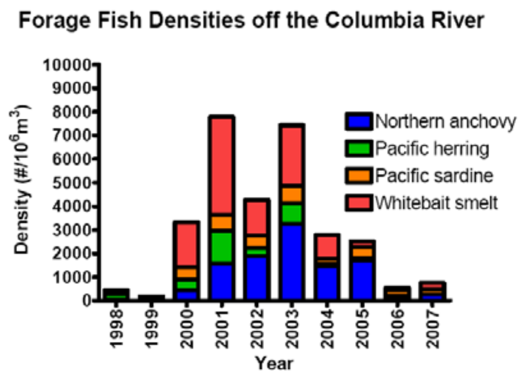


COASTAL UPWELLING

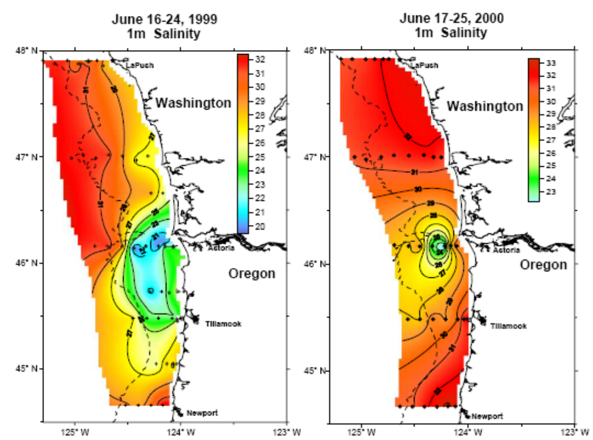
Ed Casillas of the Fisheries Science Center in Seattle noted that assessing the physical and biological conditions in the ocean off the coasts of Oregon and Washington is helping to improve our understanding of impacts on salmon and steelhead. Throughout most of the 1980's and 1990's, ocean conditions in the Pacific Northwest region were poor (see red bars on PDO graph at right), and ocean survival of Columbia River salmon was significantly affected. New insights now demonstrate that variations in salmon abundance are linked to variation at spatial and temporal scales that biologists and managers have not previously taken into account (the entire North Pacific Basin and decadal time scales).



Over the past eight years, research has demonstrated that the distribution, abundance, condition, and survival of juvenile Columbia River salmon vary synchronously with ocean conditions. Note in the figure at right that forage fish availability was good to high from the years 2000-2005, a time period coinciding with cool PDO temperatures in the graph above.



Ocean conditions may be defined as that set of factors that control the growth and survival of salmonids during their life at sea. Those factors include ocean circulation, water temperature, upwelling, and the quality and quantity of the salmonid prey base. Ocean conditions affect the abundance of salmon predators (both fish and birds) and of pathogens. Each of these factors are highly variable and vary on seasonal, interannual, and decadal time scales. These findings have given us new insights into the climate-ocean linkages and mechanisms which influence marine survival of coho and Chinook salmon and steelhead.

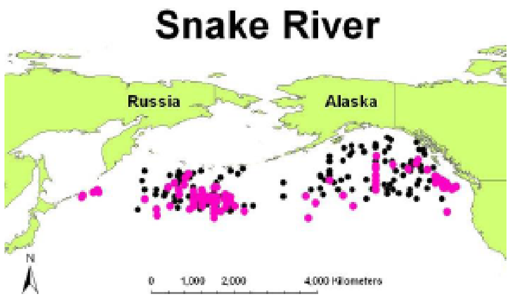


Variation in Plume salinity

This information can be used to forecast how changing ocean conditions and future climate change will affect salmon. Understanding how ocean conditions affect juvenile salmon survival and eventual adult returns is necessary in order to manage and assess the benefit of freshwater actions taken to recover and rebuild endangered salmon populations.

Kate Myers, principal investigator in the High Seas Salmon Research Program at the University of Washington, said the key findings from a number of salmon research projects in the ocean are that:

1) Biodiversity in freshwater and ocean life histories makes Columbia River salmon resilient to changes in the ocean that affect their survival;
2) Columbia River salmon species, life-history types, and specific populations have different ocean distribution and migration patterns, which mean they experience different ocean conditions;
3) Comprehensive fish-tagging strategies can provide information needed to improve high-seas fisheries management;
4) Because, we cannot accurately predict the future, management strategies that ignore the effects of changing ocean conditions on Columbia River salmon are likely to fail.

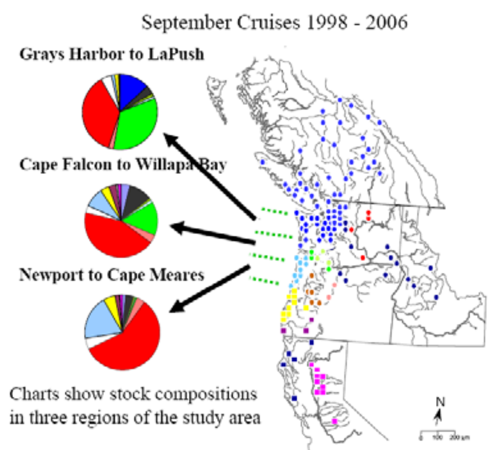


Snake River steelhead ocean distribution

Policy Implications for FWP Amendment Process

The scientists who discussed ocean research had the following recommendations for policy-makers:

1. Because under certain conditions, it appears the ocean has limited capacity to support salmon and steelhead, and because conditions vary from year to year, it is likely important to not overwhelm wild fish in the ocean with hatchery fish when ocean feeding conditions are poor. This means that hatchery production should be adjusted to account for ocean conditions. The challenge will be to have the information about ocean conditions far enough in advance – at least two years – to adjust hatchery production schedules.
2. Harvest rates could be adjusted in response to conditions in the ocean to take fewer fish when conditions are poor and it is likely that fewer fish are available



Chinook - Genetic Stock ID analysis

3. While the future cannot be predicted, salmon management strategies that ignore the effects of changing ocean conditions on Columbia River salmon are likely to fail.
4. Critical ocean habitats could be identified in order to plan for the future effects of climate change.
5. Fish transportation and spill operations could be improved to maximize early ocean survival of salmon.
6. Strategies could be planned to meet escapement goals using stock-specific estimates of early ocean survival and abundance.

Roundtable Discussion Points

Bill Pearcy (ISAB and presenter)
With global warming, we can expect to have more ocean temperature stratification. One theory, from about 13 years ago, was under climate change upwelling may increase to offset the effect of stratification.

Rick Williams (Facilitator)
It is interesting to see how myths we had three decades ago about the ocean now look naïve. One is forced to wonder what current assumptions or myths will look naïve decades from now. Failing to question our assumptions can lead to mismanagement (without knowing it!) and can lead to catastrophic collapses, as seen in the Atlantic cod fishery off the Grand Banks.

Ed Casillas (NOAA Fisheries)
Why are our research efforts focused on just the coast? Do we have to research the whole ocean? Research indicates that the juvenile salmonids really are on the Coast -- 200 km -- after sampling farther out to sea and not finding salmon. Higher fish densities are associated with chlorophyll "hot spots." Thus, future sampling efforts will only survey out to the 200 km mark.

Bill Booth (Council, Idaho).
If you can do predictive modeling a few years out, can you deliver fish at different levels to effect different conditions?

Bill Pearcy (ISAB and presenter)
Research indicates that there is density dependence in the ocean in poor years; hatchery fish can likely overwhelm the system and compete with wild fish. In 1980s and 1990s it is questionable whether we should have been putting out so many hatchery fish.

Rick Williams (Facilitator)
Do we have a coordinating system in place that would allow us to modulate production in the artificial production system to achieve different levels of release of hatchery fish based on wild fish numbers and predicted ocean conditions? (No we do not!).

Steve Yundt (IDFG)-
Are you willing to take juvenile hatchery fish to the landfill? The adaptive management camp has advocated for large experiments. Perhaps a study can be done with small, medium, and large releases.

Bill Pearcy (ISAB and presenter)
Nate Mantua (UW scientist) would say forget about predictions; with climate change, think about diversity of stocks. The best thing we can do for the future is to think about the diversity of stocks.

Nancy Huntly (ISAB)
This was an interesting data set, the time structure seems like it might be used for managing harvest, but the timeframe doesn't look as promising for hatchery fish? What about directional climate change; does this affect the forecasts?

Ed Casillas (NMFS)
It could be predictive for harvest, for hatchery it would likely be a within-year decision after the fish have been raised. The PDO hypothesis is primarily based on a 60-year pattern, and the recent pattern is much more variable.

Bill Tweit (WDFW)
Harvest managers are working on Bill Pearcy's comment on harvest rates, thinking of relative abundance of hatchery and wild fish. They are also looking as selective harvest. They've heard the message to maximize diversity. This pertains primarily to wild fish, but they are also attempting to manage hatcheries for diversity. Sometime we need to protect wild fish and will need to constrain harvest across the board. This is a challenge the harvest managers take seriously and discuss in each planning iteration.

John Ferguson (NOAA Fisheries and presenter)
Howard Schaller's analysis showed effects were upriver. Do the upriver and downriver stocks go to different areas? For Snake River and John Day stocks, is there a difference in ocean distribution? Work on genetic baseline of Columbia River Basin would benefit Columbia and international understanding and fish.

Mark Trudell (Canada DFO scientist)
Researchers have recoveries from Yakima and their distribution is similar to the Snake River.

Bill Tweit (WDFW)
Researchers and managers are also excited about having a Pacific Rim genetic baseline. Also, this seconds the recommendation to mark all hatchery fish. For example, otolith marks can tell you a lot more than an adipose mark. Recent work is being conducted in California using genetic information to re-focus harvest on real-time. They are looking at incorporating this technique in the Columbia.

Rick Williams (Facilitator)
For decades, scientists, including the SRG, ISG, ISAB, and ISRP have recommended that all hatchery fish be marked. Without a method of unequivocally identifying hatchery fish (and wild fish), it is impossible adequately manage wild fish and assess fisheries, harvest, hatchery, and habitat management actions.

Eric Loudenslager (ISRP)
The caution on the need for mass marking is reasonable for accounting purposes, but harvest managers are worried about effects on CWT program and ability to manage mass-marked selective harvest. There are indicator stocks and survival is based on this. If you have selective harvest, you lose the ability to estimate impacts and harvest on wild fish. Selective fishing in ocean is fraught with challenges.

David Welch (Scientist)
A lot of what is inferred as freshwater impacts is confounded by ocean impacts. This can lead to major policy mistakes. In the Columbia, there is so much research going on that simultaneous collapse of other fisheries is not being considered together. For example, lamprey have collapsed up and down the coast at a consistent time with the salmon decrease. There would be benefits to bring the results together.
