Independent Scientific Advisory Board
for the Northwest Power and Conservation Council,
Columbia River Basin Indian Tribes,
and NOAA Fisheries
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MEMORANDUM June 21, 2005

TO: Melinda Eden, Chair, Northwest Power and Conservation Council
Olney Patt, Jr., Executive Director, Columbia River Inter-Tribal Fish Commission
Usha Varanasi, Science and Research Director, Northwest Fisheries Science Center, NOAA Fisheries
D. Robert Lohn, Regional Administrator, NOAA Fisheries

FROM: Eric J. Loudenslager, ISAB Chair

SUBJECT: ISAB Harvest Report

The Independent Scientific Advisory Board (ISAB) is pleased to submit its *Report on Harvest Management of Columbia Basin Salmon and Steelhead* to the Northwest Power and Conservation Council, the Columbia River Basin Indian Tribes, and NOAA Fisheries.

The report was produced at the request of the Northwest Power and Conservation Council, the Columbia River Inter-Tribal Fish Commission, and NOAA Fisheries, who posed a series of harvest-related questions to the ISAB. The ISAB's review of the current scientific and institutional structure for harvest management leads to answering the questions posed.

The ISAB investigated, and reports on, the biological basis and management processes involved in providing and controlling harvest, how uncertainty in information and parameter estimates can be accounted for in decision making, and how harvest may be integrated with recovery objectives. The report also provides brief reviews of past management practices, current institutional structures for harvest management of Columbia River salmon, and background information on five topics related to salmon production and harvest management. For people less familiar with this topic, an introductory description of harvest management terminology and practices is included (Section 7e).

To summarize, the ISAB is impressed with the management processes that have been developed and the ongoing efforts to expand the scientific basis for recovery. Significant progress is evident in several areas important to harvest management, such as the definition of independent population units, criteria for population and ESU viability, establishment of the Pacific Salmon Treaty and the role of the PFMC in limiting ocean fishing impacts, the renewed in-river fishing agreements, and recent efforts to integrate analysis of the 4-Hs in determining salmon production.

We are, however, concerned about the relative effect of harvest on the conservation of naturally produced salmon. We conclude that three essential components of harvest management are deficient. These are:

1. insufficient quantitative data for analyses by production units;
2. very limited evidence of assessment analyses by production units to provide a biological basis for production goals and trends in status; and
3. limited evidence of accounting for uncertainty in management plans with the exception of reference to precaution in the National Standard Guidelines established under the Magnuson-Stevens Fishery Conservation and Management Act.

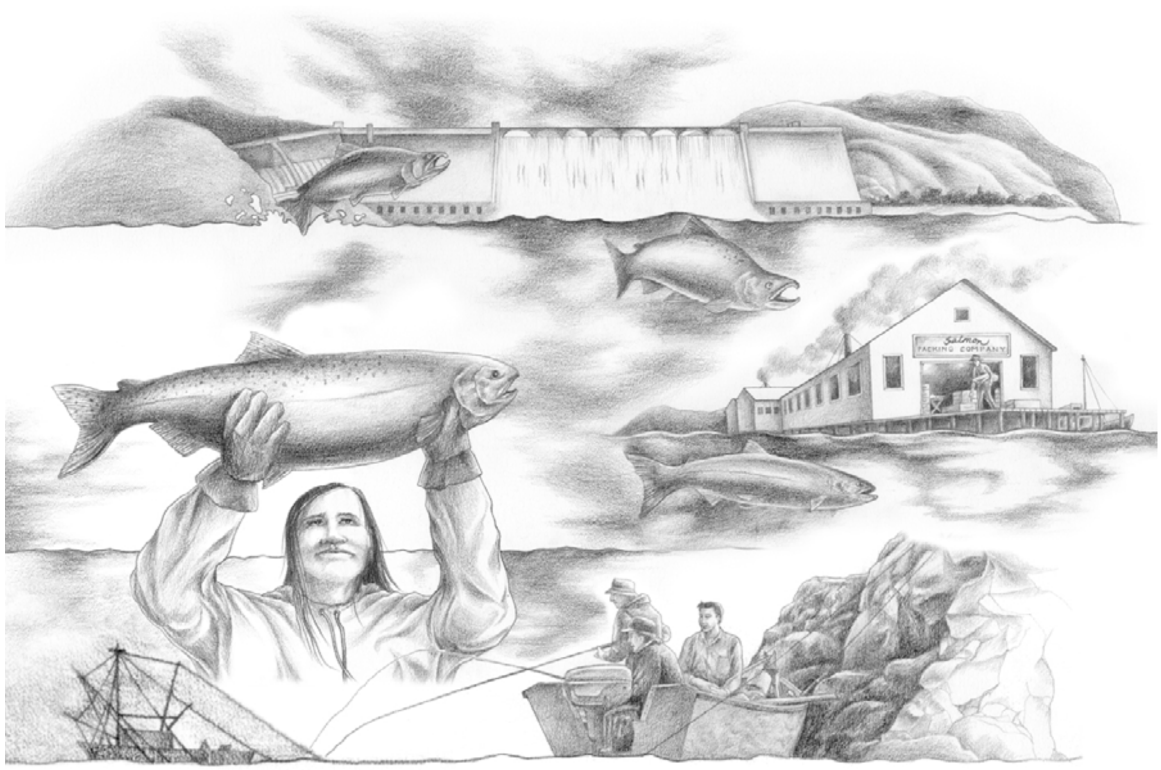
The bases for these summarizing comments and our recommendations to address them are the heart of the report.

Addressing these deficiencies would improve identifying and quantifying mortality from all sources affecting a given population throughout its life cycle, provide biological goals for management, and provide clear early signals of non-sustainability should it occur.

The ISAB looks forward to clarifying and elaborating on our conclusions and recommendations when the Northwest Power and Conservation Council hosts a harvest discussion at its meeting on July 12, 2005.

Independent Scientific Advisory Board

Report on Harvest Management of Columbia Basin Salmon and Steelhead



Executive Summary

(Excerpted from Full Report)

For Full Report: www.nwcouncil.org/library/isab/isab2005-4.htm

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ISAB Harvest Report
ISAB 2005-4

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Executive Summary

This report focuses on the role of harvest management in the conservation and sustainable use of salmon and steelhead from the Columbia River system.[1] With an interest in clarifying how harvest interacts with habitat, hydro, and hatcheries (the other H's) in the Columbia River Basin, the Northwest Power and Conservation Council, NOAA Fisheries, and the Columbia River Intertribal Fish Commission developed a series of harvest-related questions and requested the Independent Scientific Advisory Board (ISAB) produce a report that addresses those questions. The ISAB's review of the current scientific and institutional structure for harvest management leads to answering four questions that encompass the questions posed by the sponsors. The report also provides brief reviews of past management practices, current institutional structures for harvest management of Columbia River salmon,[2] and background information on five topics related to salmon production and harvest management, including an introductory description of harvest management terminology and practices (Section 7e) for people less familiar with this topic. Although harvest management and salmon recovery can be assisted by the use of "best available" science, science alone is not sufficient. Science serves as the basis for harvest management decision making, but management also comprises differing cultural and socio-economic perspectives.

The ISAB is impressed with the management processes that have been developed and the continued efforts to expand the scientific basis for recovery of depressed populations of naturally produced salmon and steelhead. The elements of science, commitment, cooperation, and investment are all evident and progressing in the Columbia River Basin. We remain, however, concerned about the conservation of naturally produced salmonids and the relative effect of harvest on their conservation. Harvest is only one part of this complicated picture, but fishing is frequently targeted as a first management action because it removes mature salmon that could otherwise return to reproduce.

Components of effective harvest management systems

Within the context of this assignment, the *ISAB's vision* of conservation and sustainable use is centered on decision processes that are necessary to ensure that the removal (i.e., total mortality from all sources) of Columbia River salmon does not exceed the productive capacities of

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[1] The terms conservation and sustainability involve diverse perspectives and values, resulting in different meanings for different people. The terms embed implicit references to objectives, time horizons, discount rates, and tradeoffs, which take on explicit meaning only when defined for a particular context. Neither term can be defined in the absolute, because each combines economic and social, as well as biological and ecological, elements in varying combinations. The ISAB did not attempt to develop specific definitions of these terms, recognizing the diversity of issues involving salmon and people in the Columbia River Basin.
[2] Throughout this report, when the term "salmon" is used in a general sense, it is meant to encompass salmon and steelhead, "salmonids."

naturally spawning populations over the long-term. From this perspective, effective harvest management systems must have three primary components:

1. A sound scientific foundation for management;
2. Clearly defined priorities and objectives for resource conservation and fisheries management; and
3. The capacity to constrain total fishing mortality on a population to a level that proves sustainable after accounting for all sources of mortality throughout the population's life cycle.

<u>1. Sound Scientific Foundation</u>

Science must effectively inform decision making for harvest management. Science is involved in designing monitoring programs, collection of data, and the development and use of reliable methods of analysis to assess biological status of the populations and fishery impacts. These assessments frequently involve limited data or data that vary in quality though time, and "noisy" data from complex ecological and social systems. Most types of information collected about Pacific salmon involve large variability (and/or limited predictability) due to natural variation in environmental conditions, changing habitat conditions over time, and the complex interactions of biological communities and salmonid ecosystems. A sound scientific basis for harvest management would: (1) provide the best practically obtainable and pertinent data; (2) provide the "best available science"[3] at the time decisions are made; (3) appropriately account for uncertainty, and (4) ensure transparency for the basis of advice, analyses, competent peer review, and a process for regular review and response (learning) as experience is gained.

Given the uncertainties and unknowns that remain in salmon management and recovery, a priority should be placed on ensuring a stronger empirical basis for assessing trends and status in each production unit, and on obtaining key information required to control harvest impacts. Well-designed monitoring programs are required to collect data on fisheries and escapements. A sound scientific basis for harvest management would inform decision-makers of the need for better information as harvest approaches the limits sustainable by the productive capacity of the resources as well as of the trade-offs between uncertainty and costs of management. In the absence of adequate data, managers should reduce impacts on the resource to ensure its continuance and future productivity.

<u>2. Clearly Defined Management Objectives</u>

Effective harvest management requires: (1) definition of the *production units*[4] to be managed; (2) biological conservation targets for each production unit; and (3) objectives and priorities for fisheries and clearly defined risk tolerances.

[3] The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) requires that harvest management decisions use the "best available science." The MSFCMA contains ten National Standards for fishery management plans, and guidelines for implementing these standards are applied in decision-making processes of regional fishery management councils (see discussion of current institutional structure).

[4] Production unit in this discussion is a spatially defined group of salmon populations and hatcheries that are determined by the responsible agencies as a basis for conservation and management. Typically, each unit would be demographically independent and there could be several such units within an ESU.

Recent identification of independent population units is notable progress in characterizing the resource base, but conservation targets are not as well defined and are often not fully integrated with harvest management capabilities. For instance, although component populations of Evolutionarily Significant Units (ESUs) can be identified, little data may be available to determine the level of harvest that can be sustained by those individual components, and fisheries may be regulated through the use of indicators of population aggregates.

Objectives for harvest management include biological, legal, and socio-economic considerations. Biologically, harvest impacts must be constrained to lie within the productive capacity of the populations that comprise the resource base. Legally, harvest management must comply with international and Indian treaty obligations, as well as requirements set forth in federal, state, and tribal law. Socially, harvest management must distribute the benefits of harvest and responsibilities for conservation in a manner that is acceptable to the public and defensible against legal challenge. The suite of harvest management objectives affecting Columbia River salmon is embodied within management plans and legal requirements, such as the Pacific Salmon Treaty agreements, the Pacific Fishery Management Council's Pacific Coast Salmon Plan, the recently agreed "2005-2007 Interim Management Agreement for Upper Columbia River Chinook, Sockeye, Steelhead, Coho and White Sturgeon (*U.S. v. Oregon* Parties 2005)", and the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA).

In spite of all of the data that have been collected on Pacific salmonids, the reality is that fisheries management is inexact. There are many sources of uncertainty, but science must provide information and advice in the face of both risk and uncertainty. Risk can be minimized and future options preserved in a dynamic and unstable environment by maintaining a genetically diverse mix of component populations and their habitats. A sound harvest management decision process would protect a minimum spawning population size in each unit, given the current and potential future range of environmental conditions and the range of error in assessments.

3. Capacity to Constrain Total Fishing Mortality

The capacity to constrain harvest of Columbia River salmon requires: (1) consistent quality-assured data for pre-season planning and in-season monitoring; (2) clear management objectives and timely in-season decision processes; and (3) management accountability.

With a multitude of institutions having regulatory authority over Columbia River basin fish, there would seem to be ample opportunity to constrain total fishing mortality through both regulations and enforcement. Unfortunately, the distribution of responsibility for achieving the biological conservation targets for individual production units is fraught with such controversy that the aggregate result is often less satisfactory than required.

The capacity to constrain harvest of Columbia River salmon is determined by the institutions involved in regulating fisheries throughout the migratory ranges of individual production units. The institutional structure of harvest management is extremely complex, involving many private, local, regional, state, tribal, federal and international entities. Because many jurisdictions typically affect the harvest of Columbia River salmon, fishery management decision processes must be sufficiently coordinated to collect consistent biological data and accomplish management objectives for production units of interest. These entities operate within their own jurisdictions, but often have overlapping authorities and responsibilities.

The ISAB recognizes that some of the limitations on constraining harvest mortality are due to basic inability to scientifically sort out population dynamics and total mortality for individual populations involved in multiple, mixed-stock fisheries. For an escapement objective for each salmon population to be achieved, not only must management define the desired number of spawners for each population, it must also regulate multiple fisheries to achieve them. This level of harvest management control in salmon fisheries is unrealistic because most fisheries simultaneously exploit a mixture of salmon populations and the actual catch by stock is usually unknown. Additionally, errors in pre-season forecasts, changes in return timing, variation in the response of fishermen to opportunities, and weather all confound our ability to accomplish management objectives for individual production units. Further, in the context of managing fisheries, it is important to differentiate what is known about salmon and our capability to control harvest impacts on specific populations. The latter is referred to as management control error and is frequently not fully accounted for in planning.

Concerns

The issues involved with harvest management are complicated, with many agencies and salmon populations involved and numerous legal requirements and historical complications (past impacts of development, mitigation and legal backgrounds including the massive hatchery production, conflicting objectives, limited historical data, etc.). Significant progress, however, is being made in several areas important to harvest management, such as the definition of independent population units, development of criteria for population and ESU viability, establishment of the Pacific Salmon Treaty and the role of the PFMC in limiting ocean fishing impacts, the renewed in-river fishing agreements, and recent efforts to integrate analysis of the 4-Hs in determining salmon production. While the ISAB has been favorably impressed with the development of biological science and management processes, three fundamental components of harvest management are noted as significant concerns. These include:

1. insufficient quantitative data for analyses by production units;
2. very limited evidence of stock assessment analyses by production units to provide a biological basis for production goals and trends in status; and
3. limited evidence of accounting for uncertainty in management plans with the exception of reference to precaution in the National Standard Guidelines established under the MSFCMA.

Given the severe limitations of historical data, the complex interactions of the 4-Hs, and the number of salmon production units listed under the ESA, managers should clearly reflect on the appropriateness of harvest rates, their ability to control fisheries, and their ability to explain the status and trends in Columbia River salmonids. A serious commitment to acquiring the empirical data for annual stock assessments, achieving the target spawning escapements (or exploitation rate), and explaining deviations is essential to function within the complex management processes involved with Columbia River salmonids. Establishing this empirical basis will serve to reduce management uncertainty and debate between agencies, focus attention on actions most necessary to recovery listed-species, and account for harvest impacts when fishing occurs. The ISAB has emphasized the need for improved quantitative information in two other recent reports: the review of subbasin plans (noting the lack of rigorous stock assessments in many subbasins) and the supplementation review (noting the information needed for assessments). Improving the information quantity and quality will not, however, stop debates over harvest. Conflicts in harvest opportunities between hatchery and natural stocks, between species, and between cultural and socio-economic values will continue. The value of improved information in this context, though, is that accurate assessment of harvest impacts may enable: (1) compensatory actions in the other H's (i.e., integration of mortalities through the life cycle of the salmon); (2) reconsideration of management objectives (e.g., are time scales of recovery realistic?); and (3) review of the relative values and costs associated with this harvest impact.

Recommendations

Based on our review and questions posed by the sponsors, the ISAB presents four recommendations:

1. Core Monitoring Data

There is an essential need for a core set of quantitative data to be monitored annually in all production units or, at least, in a sub-sample of units that may be used as representative indicators of productivity and trends in abundance over time. With the obvious importance of defining recovery goals and then monitoring progress to recovery, establishing quantitative indicator systems within ESUs is required for a credible harvest management system. A monitoring framework with probabilistic sampling designs should be required for each ESU and population unit defined by the Technical Recovery Teams, as well as for stocks that are not listed. These data collected annually provide for the critical analytical assessments necessary to advise management and selection of recovery actions. The ISAB strongly cautions against the collection of data without parallel careful design, use, and evaluation.

2. Documented Assessments

While the ISAB reviewed many reports, biological opinions, scientific papers, and management plans, there were very few quantitative and documented analytical assessments of individual production units or ESUs. Such assessment reports would typically provide the basis of biological advice on Pacific salmon that subsequently becomes the basis for harvest management planning. Detailed assessments must be documented and peer reviewed to provide quality control to the scientific basis of management planning.

3. Accounting for Uncertainty

While many documents refer to uncertainty, there were very few examples of actually estimating uncertainty or accounting for it in a management plan. Analysts likely know much less about the production dynamics of Pacific salmonids than is assumed, and uncertainty is very likely to be much greater than appreciated or accounted for. Guidelines for the estimation and accounting of uncertainty in management targets and in-season management control should be developed and applied. All sources of fishing mortality must be accounted for and a level of risk tolerance established through public consultation. While the ISAB was impressed with the intensive process used for salmon management, we also recommend analysts review whether current levels of harvest impact are consistent with the quality of data and level of uncertainty in the biological and management processes, and provide the expected likelihood of recovery for these listed species.

4. Adaptive Management in Salmon Recovery

Given the limitations in historical data, the limited progress on recovery planning, the inherently large uncertainty, and the complexity of management processes involved in harvest management of Columbia River salmonids, the ISAB recommends application of adaptive management principles in salmon recovery. Although the ISAB acknowledges potential problems with implementing a truly adaptive program in such a complex environment, the ISAB believes that a systematic approach to testing alternative actions with an emphasis on achieving secure spawning escapement levels should again be seriously considered. Such alternative actions may include stepped harvest rates weighted to protect minimum spawning levels, manipulations of hatchery production and/or the hydrosystem flows, and testing of incentives for recovery.

Recommendation 4 may also be an appropriate action for addressing how the Columbia River Basin should assess and adapt to the risks of climate and ocean changes on Columbia River salmonids. As discussed in Section 7d of this report, the ISAB anticipates significant increases in understanding of climate and ocean changes and cycles in relation to salmon and other natural resources in the next few years, and significant increases in the uncertainty of production forecasts in the short to medium term. Harvest managers and the harvest industry need to be in close touch with this understanding and adjust their procedures accordingly for conducting assessments, setting allowable harvests, and harvesting fish.

ISAB Reply to Sponsors' Questions

1. Contrast current and past harvest practice, addressing whether harvest rates and total fishing mortality on Columbia River stocks have increased, decreased, or remained constant?

Fishery impacts on Columbia River salmon have been reduced since the mid-1980s due to harvest management measures taken to respond to a variety of factors. The reductions have not been equal across species but three examples are presented in Appendix C to illustrate reductions in fishery impacts on Columbia River salmon and discuss underlying reasons: (1) Upriver Bright Fall Chinook (URB); (2) Coho; and (3) B-Run Steelhead.

2. Does current harvest management adequately manage and protect ESA listed naturally spawning populations?

This question cannot be definitively answered until recovery objectives are established for ESA-listed populations, determinations are made as to which component populations within ESUs must be protected to maintain their viability, and quantitative risk tolerances are adopted. Until then, ambiguities will continue to surround interpretation of the phrases "adequately manage and protect" and "ESA-listed naturally spawning populations." Under the current system of ESA administration, NOAA Fisheries and the U.S. Fish and Wildlife Service have the responsibility to determine whether or not management measures are "adequate" to protect ESUs. In the absence of approved recovery plans and a quantitative risk standard, and a comprehensive quantitative methodology for assessing risk and factoring the uncertainties into that assessment, agencies have considerable latitude in implicitly defining "adequacy" in their jeopardy findings and the annual guidance they provide for harvest management.

The current focus on "adequacy" should be squarely placed on whether management measures are sufficient to make predictable progress toward population recovery on the basis of those factors that are reasonably well-characterized, and maintain options, avoid irreversible damage, and monitor status with respect to factors that are very uncertain. Because of the potential for rapid adjustment of harvest, and given the existence of systems that collect and analyze data in a timely manner to monitor impacts, harvest management measures can be adjusted both annually and in-season. Consequently, harvest management is much more likely to be capable of preserving options for recovery than other types of measures that may be involved, such as habitat improvements or modification of flows and dam passage facilities. This greater flexibility, however, carries the liability that harvest management may be called upon to bear a greater share of the conservation burden in a crisis situation. It is essential to note, though, that if the predominant limiting factor to recovery is not harvest, then those other factors must be addressed, or the value of reduced harvest will be temporary and not sufficient for recovery.

3. What are the consequences of mark-selective fisheries on the accuracy and precision of forecasting and on consideration of harvest regime options? Are there practical measures that could be implemented in the short- or long-term to address the challenges posed by mark-selective fisheries?

Generally, mark-selective fisheries can be expected to increase uncertainty in harvest management of natural (unmarked) stocks, in terms of both precision and bias. The consequences of mark-selective fisheries are situational. Depending on the location and intensity of harvest, mark-selective fisheries may or may not have a significant effect on a variety of harvest management tools, such as estimation and forecasting of in-season run size. The reports of the Pacific Salmon Commissions Selective Fishery Evaluation Committee identify and discuss potential effects of mark-selective fisheries on harvest and management tools (ASFEC 1995). Additionally, a report in preparation by the Expert CWT Panel convened by the Pacific Salmon Commission in June 2004 will address this issue in depth.

Two important factors should be recognized when dealing with mark-selective fisheries. First, the capacity to conduct mark-selective fisheries depends upon continued investment in hatchery production and mass-marking. There are significant ecological risks associated with developing fishing strategies that depend on sustained hatchery production that should not be cavalierly dismissed (e.g., density-dependent competition and/or predator dynamics involving interactions of hatchery and naturally produced juveniles). Second, the costs of mass-marking, double index tagging, and sampling/reporting programs for catch and escapement will likely strain agency budgets and result in reduction of services or other programs, such as data collection, research, or enforcement. If investments are not made to improve sampling and reporting programs, management uncertainties will increase and impose costs to compensate.

4. Are analytical tools sufficient to adequately track future harvest rates? If not, what tools or performance standards will be most effective for managing fisheries? Are there opportunities to use PIT tags to improve management capabilities and reduce uncertainty?

Harvest management of Columbia River salmon involves a number of data collection systems that monitor impacts and analytical tools to evaluate results. The determination of "adequacy" of these tools, however, is situational and beyond the capabilities of ISAB to evaluate in this report. An independent analysis may be helpful to provide an in-depth evaluation of current tools and methods and to develop recommendations for improvement.

To-date, much of the information employed for the management of Columbia River salmon is derived from analysis of coded-wire tag (CWT) data. Analysis of CWT recovery data must frequently involve statistical inference because this technology is based on group marking and single recoveries (sacrificial sampling is required to recover data) of individual members of a group. These characteristics require assumptions and interpretation to address questions of interest to managers and researchers. Coded-wire tag technology is over thirty years old.

Newer technologies are now available and capable of providing data and information that is unattainable from coded-wire tags. One of these technologies is the passive inductive transmitting (PIT) tag that can potentially provide data for estimation of natural and release mortality rates, migration patterns and rates, and growth rates. Additionally, since data from PIT tags can be recovered without mutilating the fish, market values of the fish are not affected, thereby eliminating the barriers to processor and fishermen cooperation. The region should begin planning of long term monitoring of life history parameters, including harvest mortality, of hatchery and wild fish by use of PIT tags. The potential application of PIT tags in harvest management is being considered by the Coded-Wire Tag Expert Panel of the Pacific Salmon Commission, which will be reporting in the summer 2005.