

Cost-Effectiveness Strategies for the Fish and Wildlife Program:

Progress and Potential

**Independent Economic Analysis Board
with Council Staff**

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EXECUTIVE SUMMARY

The Northwest Power Act contains language promoting the cost-effectiveness of the Council's Fish and Wildlife Program (the Program). The Independent Economic Analysis Board (IEAB) assists the Council in its responsibilities with respect to cost-effectiveness. Perhaps the two most common questions the IEAB fields are "What has the Council done to ensure that the Program is cost-effective?" and "What else could be done to make the Program more cost-effective?" This paper attempts to address these questions.

Part I of this paper documents how changes in project management, scientific review, and planning have been used to promote scientific assessment and cost-effectiveness of the program. This section, written with Council staff, provides a historical perspective on the progress of the Program over time.

Following a 1996 amendment to the Act that strengthened cost-effectiveness considerations for the Program, the Council developed a paper that included four strategies for improving the cost-effectiveness of the Program. Those strategies are:

- Ensure the biological effectiveness of Program measures,
- Increase the use of cost analysis in project selection and prioritization,
- Analyze project histories in more detail, and
- Improve project contract management by the Bonneville Power Administration.

There has been progress in each of these areas since the Council's first Program. The Program includes a large science component whose main purpose is simply to ensure that projects have benefits for fish and wildlife. Increased focus on the science of fish and wildlife recovery actions was promoted even before the 1996 amendment to the Act with the formation of the Independent Science Group in 1995 and its predecessor groups dating back to the first Program in 1982. Their paper on "Return to the River" focused planning on ecological and biological foundations. Following the 1996 amendment, the Council created three independent scientific groups to help enhance the effectiveness of fish and wildlife projects. The Independent Scientific Review Panel (ISRP) provides the Council with independent scientific review of fish and wildlife projects. The Independent Scientific Advisory Board (ISAB) fosters a sound scientific approach to the recovery and research programs of NOAA Fisheries, the Council, and the Columbia River Tribes. The Council established the Independent Economic Analysis Board (IEAB) in November 1996 to advise the Council on cost-effectiveness and other economic issues associated with the Program.

The work of these boards has not only improved the biological effectiveness of projects, it has also contributed to improved project management and review and increased reporting, data availability, and cost review. Specific examples include development of project proposal forms that improve the amount and consistency of information provided, improved data and models to track and assess the status of fish and wildlife, and project management systems such as Bonneville's Pisces and Taurus programs. A number of Bonneville and Council management

initiatives have sought to document and control costs and compare projects in terms of their purposes and costs to avoid wasting Program, state, and federal funds.

In addition to progress on the individual project level, recommendations of the independent boards and Council actions have improved the overall effectiveness of the Fish and Wildlife Program. For example, the ISRP played an important role in developing improved proposal requirements, subbasin planning, and categorical reviews, all of which contribute to an improved Program. Four broad retrospective reviews of Bonneville funded projects were produced by the ISRP in 2005, 2007, 2008, and 2011 to help assess Program accomplishments and identify potential improvements. The Council has made gradual improvements to the Program in terms of more specific objectives, overall Program framework, rebuilding targets, implementation plans, and measurable performance standards. The Council is further refining the biological objectives of the Program. This initiative will play a key role in tracking the effectiveness of the Program and prioritizing actions to most cost-effectively reach its goals.

In summary, there is good reason to believe that the cost-effectiveness of the Program has improved greatly over the nearly 30 years since passage of the Northwest Power Act. For the most part, these improvements cannot be measured in monetary terms for each increment of improvement in fish and wildlife population or survival. Rather, the improvement has occurred incrementally over time and in ways that do not attract much recognition. The improvements result from improved scientific assurance of fish and wildlife enhancements, greater specificity of project goals, improved management of project costs, better reporting and data on projects, greater coordination among projects within subbasins, and more specific Program goals and tracking of accomplishments.

In spite of the many important improvements in management, science, and planning, the IEAB believes that further cost-effective improvements are possible. Part II of this paper discusses how additional effort, information, and analysis might be used to further improve the cost-effectiveness of the Program.

First, cost-effectiveness involves comparison of alternative ways of accomplishing a given goal. Past efforts at considering alternatives, and the future potential range and timing of alternatives, are not well-documented. Future efforts to consider alternatives and their costs would benefit from this documentation.

Opportunity for improved cost-effectiveness of the overall Fish and Wildlife Program can be identified through continued work to refine Program objectives to be comparable to measurable Program accomplishments. In addition, expanded analysis of groups of projects with similar geographic coverage, species focus, or other objectives can reduce overlap and redundancy among projects, identify opportunities for collaboration, and help set priorities within limited budgets to maximize benefits to fish and wildlife.

The greatest opportunity for analyzing and improving Program cost-effectiveness lies in improved quantification of fish and wildlife benefits. The limited ability to measure effects of actions on fish and wildlife health and abundance has hindered cost-effectiveness analysis. Thus,

progress in identifying and quantifying biological benefits would greatly aid cost-effectiveness considerations in the Program.

A first step in improving the measurement of fish and wildlife benefits would be development of additional quantitative measures of improvements in fish and wildlife habitat benefits. Current examples of such measures include wildlife habitat units, mainstem passage measures, and use of tools like EDT (Ecosystem Diagnosis and Treatment) to estimate the benefits of physical improvements to habitat. Additional efforts are underway to address this need with quantitative estimates of survival effects of suites of actions under the biological opinion, and development of quantitative measures of survival benefit units in the estuary. If these efforts are successful in providing measures of benefits related to particular actions, the feasibility of more formal cost-effectiveness analysis will be enhanced.

Improved measurement of the biological effects of alternative actions, and their costs, would improve the ability to make cost-effectiveness comparisons. The IEAB recognizes that the measurement of the effects of actions on fish and wildlife is the province of biologists and the IEAB proposes to work more closely with the other independent science groups to identify how evolving measures of biological effects might be used to further advance Program cost-effectiveness.

Part II of the report also explains how comparisons of alternatives and their costs might be applied at various scopes; such as within projects, within subbasins, across subbasins, across species, and across jurisdictions. The first step in such analysis is to better understand the range and timing of discretion in Program spending alternatives. Improved information on alternatives, costs, and effectiveness could inform project proposals and facilitate prioritization within the Fish and Wildlife Program. However, the scope for trade-offs and prioritization within the Program is limited to some degree by treaties, ESA requirements, the fish and wildlife accords, and required Council deference to fish and wildlife agencies and tribes.

Part I. Historical and Current Status of Efforts to Improve Cost-Effectiveness of the Fish and Wildlife Program

INTRODUCTION AND PURPOSE

The Northwest Power Act contains language that promotes the cost-effectiveness of the Council's Fish and Wildlife Program (the Program). Although cost-effectiveness was not a major focus of the Northwest Power Act in 1980, there are two requirements that relate to the economics of the Program. First, the Council is to develop a Fish and Wildlife Program to "protect, mitigate and enhance fish and wildlife affected by the development, operation, and management of the [basin's hydroelectric] facilities while assuring the Pacific Northwest an adequate, efficient, economical, and reliable power supply."¹ While this is a very broad and unspecific requirement, it does require attention to the effects of the costs of the Program on the power system. "Efficient" applied in its common meaning here, implies using the minimum resources needed to accomplish a goal. "Economical" usually relates to whether a product or service is affordable in a broad sense.

The second reference to cost-effectiveness in the Act is that the Program should "utilize, where equally effective alternative means of achieving the same sound biological objective exist, the alternative with the minimum economic cost."² In contrast to the first provision, this one is very specific in requiring, where all else is equal, the selection of the minimum-cost alternative.

The role of cost-effectiveness in the Program was enhanced in a 1996 amendment to the Northwest Power Act that requires the Council to "determine whether the projects (fish and wildlife projects recommended to Bonneville) employ cost-effective measures to achieve Program objectives." The amendment language can be interpreted narrowly to mean individual projects must be cost-effectively implemented, but it can also be interpreted more broadly to suggest that all projects, taken together, constitute a cost-effective approach to meeting Program objectives. The 1996 amendment also requires independent scientific review of projects, which helps ensure that project benefits are documented.

The purpose of Part I of this paper is to describe how the Council's Program has evolved over time to address these cost-effectiveness requirements. We use the concept of cost-effectiveness broadly. Cost-effectiveness requires science, management and planning to ensure that Program goals are being accomplished by projects. For example, scientific review of a fish and wildlife project is likely to help ensure that money spent creates real biological improvement. Management actions that improve the implementation and accountability of a project are likely to result in more effective use of project funds. Better coordination and planning among projects is likely to result in better overall use of fish and wildlife restoration funds.

¹ Northwest Power Act, Section 4(h)(5).

² Northwest Power Act, Section 4(h)(6)(C).

Long-Term Strategy for Improving Cost-Effectiveness

Cost-effectiveness means achieving an objective with the least cost. A general goal of the Program is to increase populations of native fish and wildlife. However, the objectives of the Program and of individual projects have not always been clearly defined, and this lack of clarity has created a problem for measuring the Program's cost-effectiveness.

The application of cost-effectiveness analysis has also been limited by the inability to accurately measure the biological effects of projects on fish and wildlife populations. These populations are affected by many complicated interactions. There may be a large number of factors limiting populations over space, time and life stages. Even if an action provides a predictable increase in survival or population at a given life stage and place, this may not translate to a predictable, sustained population increase. Consequently, there are no generally accepted methods for forecasting population changes resulting from actions funded by the Program.

A further problem for cost-effectiveness analysis is that the Program has multiple objectives. Cost-effectiveness analysis cannot help decide how money should be allocated across these objectives. Many habitat and passage projects have multiple benefits in terms of species targeted for improvement. If such projects have relative differences in benefits across species, how can they be compared?

A second-best approach to cost-effectiveness assessment is to measure some intermediate objective that is thought to be positively correlated to improvements for fish and wildlife, for example the numbers of smolts, percent survival of smolts, and miles or acres of habitat restored. Assessing alternative approaches and costs to achieving these intermediate objectives should identify options to improve the overall cost-effectiveness of the Program. Defining the relationship between intermediate objectives and improvements for fish and wildlife is one reason for monitoring and evaluation and the development of models such as Ecosystem Diagnostics Tool (EDT) that attempt to measure the relationship between physical actions and fish and wildlife productivity.

Following the 1996 amendment to the Act, the Council developed a paper that addressed requirements for cost-effectiveness determination (NPCC 1997). The paper discussed how economics might be applied to the Program, and the limiting factors for such analysis. It reviewed several existing attempts at economic analysis of fish and wildlife actions. The general conclusion was that formal analysis of the cost-effectiveness of most fish and wildlife mitigation actions is limited by the inability to measure the biological effects of the actions.

The paper developed a four-part strategy for promoting the cost-effectiveness of the Council's Program. First, design the Program to ensure the biological effectiveness of the measures. This was to be accomplished through the independent scientific review. Second, increase the use of cost analysis in the selection and prioritization process. Providing cost information for proposed actions could help inform Program decisions. Further, analysis of costs for particular purposes or in particular geographic areas could help assess the shape of the overall Program and its balance among various needs.

A third strategy was to analyze project histories in more detail. Have investments in a project yielded measurable benefits over time? Even if benefits cannot be explicitly measured, investments in alternative projects might be judged against the ISRP's scientific assessment of a project's likely effects.

The final strategy was improved contract management of fish and wildlife projects by Bonneville. This included more specific information on actions to be taken, expected effects, costs, and timelines so that contract managers and others could ensure that project funds were being used as intended, project deliverables were produced, and project timelines being met.

Taken together, these strategies could be thought of as improved management of, and information about, the fish and wildlife projects and the overall Program. Improved information on costs, focus of effort, and tightened project accountability are improved business practices that can be assumed to yield better review of effects and better assurances of effective use of Program dollars both for individual projects and for the overall Program. In the longer term, it was recognized that improved data and advances in understanding biological effects would lead to increased ability to assess and ensure cost-effectiveness of fish and wildlife projects and the overall program.

The following section describes how the Program has evolved over time to implement better science, and by extension, the cost-effectiveness strategy.

EVOLUTION OF THE FISH AND WILDLIFE PROGRAM

The 1996 amendment to the Northwest Power Act was not the watershed event that it might seem in improving the cost-effectiveness of the Program. By 1996 there had already been amendments to the first Program that promoted cost-effectiveness. Implementation of the four strategies described above as well as other improvements had been occurring incrementally since 1983.

Major initiatives begun before the 1996 Act amendment include:

- improved project definition,
- better coordination among projects,
- attempts to prioritize efforts,
- addition of a five-year action plan,
- adoption of an overall Program goal,
- creation of advisory and scientific review committees,
- development of a scientific framework for the program,
- development of databases and tracking systems, and
- adoption of an adaptive management approach.

1982 Program

Under the Act, the Council was given very little time to develop the first Fish and Wildlife Program. The Program was adopted in November 1982. The Council issued an open solicitation for projects from the fish and wildlife agencies, tribes, and others. There was little guidance provided in the solicitation. The Council received 400 proposals that were mostly quite general in nature. The fish and wildlife agencies and tribes conducted a negotiation process to help organize and prioritize the proposals. The Council created an advisory committee to help compile the program, but it included many of the same agencies and tribes. This approach was partly due to the deference required in the Act to the recommendations of the agencies and tribes.

The 1984 Amendments

The Program was amended in 1984. The Council recognized the problems of coordination, prioritization, and accountability for completing projects on specific timelines. These concerns are expressed in the following quotes from the 1984 amendments (NPCC 1984).

“A major concern of the Council is whether the [agencies and tribes] can be fully effective in establishing priorities...”

“...projects have not been subject to critical evaluation, nor have they been coordinated and integrated sufficiently to achieve maximum benefits...”

“The Council must ensure that ratepayer money spent on research and other Program measures will lead to actual improvements...”³

To improve the Program, the Council created a Fish and Wildlife Committee consisting of four Council members to provide more oversight and guidance. The amendments also featured a five-year action plan and created an Implementation Planning Process. Proposals contained more specificity and organization due to the existence and review of the 1982 Program proposals. The amendments also recognized the need to estimate the fish and wildlife losses due to the hydropower system and to develop a goal for the mitigation required by the Act.

The 1987 Program

The Fish and Wildlife Program was revised in 1987 (NPCC 1987). An estimate of losses and an interim goal of doubling the runs from 2.5 million fish to 5.0 million fish were adopted. However, as an aggregate goal it provided little assistance in structuring the Program or prioritizing actions. Section 1300 called for the development of project application forms to increase the amount and consistency of information on proposed amendments to the program. The 1987 Program recognized the need for system-wide planning starting at the subbasin level.

³ (NPCC 1984). Page 89.

“To achieve the salmon and steelhead goal of doubling the runs, a system-wide planning effort will be needed to ensure integration and consistency with that goal and associated policies. System planning will include planning at the subbasin level to identify local opportunities for and constraints on future enhancement efforts.”⁴

The concept of adaptive management was introduced in the 1987 Program as a way to add flexibility to adapt to changing conditions and new scientific information.

The 1992 Strategy for Salmon

Petitions for ESA listings of Snake River salmon led to the 1992 Strategy for Salmon, which amended the 1987 Program. The Council embarked on a three phase amendment process that sought regional consensus on recovery measures that could help avoid ESA listings and the accompanying recovery plans. The phases included high priority habitat and production measures in August 1991, mainstem measures in December 1991, and the Strategy for Salmon in October 1992 (NPCC 1992).

The 1992 Strategy for Salmon represented an increased focus on regional communication about the Program. Significantly for Program cost-effectiveness, it also contained requirements for increased research, monitoring, reporting and information systems. It directed Bonneville to develop a “data base and tracking system” to monitor and categorize expenditures. The Program coordinated with the ESA process, and for the first time contained the beginnings of a “framework” that included Program goals, rebuilding targets, survival targets, and performance standards and measures. All of these changes helped to focus the Program on better management and accountability for results.

The 1994-5 Fish and Wildlife Program

Amendments in 1994 and 1995 led to a new Program that promoted increased attention to the scientific and conceptual underpinnings of the plan. The 1994 amendments to the Strategy for Salmon called on Bonneville to:

“... develop and fund an Independent Scientific Group to provide a biennial evaluation of the program on its scientific merits and to fulfill other tasks described in this program. The group should examine the scientific underpinnings of the program and evaluate the program as a vehicle to achieve the Council's goals and those of the Northwest Power Act.”⁵

The result was the 1995 creation of the Independent Science Group (ISG), which developed the report “Return to the River.” A preliminary version of that report appeared in 1996 and a final version was completed in 2000 (ISG 2000). The report was notable for its focus on restoring ecological function in the river and less reliance on engineered solutions such as hatcheries, barging, and other technological approaches.

⁴ (NPCC 1987). Page 163.

⁵ (NPCC 1994-95). Section 3.2B, Page 3-11.

In its 1994-95 Program, the Council attempted to reflect the Snake River ESA listings with strong mainstem actions as well as address the broader responsibilities of the Council (NPCC 1994-95). The Program was preceded by a court decision requiring the Council to give greater deference to the recommendations of tribes and fish and wildlife agencies. This was an apparent limitation of the Council's potential role in improving the Program through increased management, coordination, and prioritization of projects.

The 1994-95 Program was described as "...the first truly comprehensive strategy for fish and wildlife in the Columbia River Basin. It is a long-range plan to amend river operations, increase productivity, repair habitat and refine harvests."⁶ This comprehensiveness was summarized as the 4 Hs: hydropower system, habitat, hatcheries, and harvest. The framework concept, further developed in the 1994-95 Program, was described as follows:

"The program framework provides the structure for the fish and wildlife program. It includes the overall program goal, rebuilding targets for identified populations, and schedules to achieve the rebuilding targets. The framework also provides the biological objectives for the program. Biological objectives describe biological change needed to rebuild individual populations. *Measures are evaluated against these objectives to identify the strategy that will achieve the objective for the least cost.* [emphasis added] Finally, performance standards provide readily measurable indices of biological and physical change expected from the measures."⁷

Finally, the 1994-95 Program contained a more detailed emphasis on data base development and coordination. Section 3.3 required Bonneville to develop a coordinated information system including databases on anadromous fish, scientific information, habitat, and project accounting.

2000 Fish and Wildlife Program

The 2000 Fish and Wildlife Program was preceded by several important events. The 1996 amendment to the Power Act, as discussed above, gave increased focus to scientific review and cost-effectiveness and importantly, gave the Council a new formal role in Program implementation through project review. In addition, the publication of *Return to the River* shifted the focus of fish and wildlife mitigation to more natural processes. The Council hosted the Multispecies Framework process in the late 1990s to improve the overall framework for the Fish and Wildlife Program, increasing its alignment with natural biological processes and balancing the human effects of alternatives. The purpose of the human effects analysis was:

"to evaluate and display potential human effects of the Multi-Species Framework alternatives (the alternatives). The alternatives represent different policies to balance the multiple uses of the Columbia River Basin. All of the alternatives are intended to enhance fish and wildlife resources,

⁶ (NPCC 1994-95). Page 1-4.

⁷ (NPCC 1994-95). . Page 4-2.

especially anadromous fish, to achieve better balance between economic and natural amenities in the Basin. The alternatives, and this Human Effects Analysis, attempt to capture a range of economic, social and tribal visions concerning what an appropriate balance should be and how this balance could be achieved.”⁸

The 2000 Fish and Wildlife Program was a significant step forward in clearly defining the scientific framework and objectives of the Program (NPCC 2000). It incorporated the results of the Multispecies Framework. It included a vision for the Columbia Basin, a scientific foundation and principles, overarching and basin-level biological objectives, and strategies designed to achieve the objectives. It committed to the future development of subbasin objectives as well as to an enhanced monitoring and evaluation program. The Program stated; “Proposed measures will be evaluated for consistency with these objectives and strategies. A primary function of the monitoring and evaluation components of this program is to measure progress toward achieving these objectives.”⁹

The significance of the changes to the Program is described in the introduction.

“The 2000 Program marks a significant departure from past versions, which consisted primarily of a collection of measures directing specific activities. The 2000 Program establishes a basinwide vision for fish and wildlife — the intended outcome of the program — along with biological objectives and action strategies that are consistent with the vision. Ultimately, the program will be implemented through subbasin plans developed locally in the more than 50 tributary subbasins of the Columbia and amended into the program by the Council. Those plans will be consistent with the basinwide vision and objectives in the program, and its underlying foundation of ecological science.”¹⁰

These shifts from a focus on individual measures and projects to broader programmatic objectives and goals represent an important opportunity to improve the effectiveness of the overall mitigation effort.

The 2003 and 2005 Amendments

In 2003, the Council amended the Fish and Wildlife Program to incorporate the mainstem provisions of the 2000 Biological Opinion (NPCC 2003). In 2005, the Council amended the Program to include 57 subbasin plans, thus completing the transition started in the 2000 Program to drive the details of the Program from the subbasin level (NPCC 2005).

⁸ (NPCC 2000a). Page 1-1.

⁹ (NPCC 2000). Page 18.

¹⁰ (NPCC 2000). Page 7.

The 2009 Fish and Wildlife Program

The 2009 Program continued the vision, framework and goals of the 2000 Program (NPCC 2009). However, a greater emphasis was placed on ensuring implementation. In the words of the program:

“The focus of the Program and the Council now turns to performance. The revised Program renews the emphasis on periodic scientific review of new and ongoing actions; increases requirements for reporting of results and accountability; emphasizes adaptive management as a way to solve continuing uncertainties; renews the push to develop a better set of quantitative objectives for the regional Program; commits to a periodic and systematic exchange of science and policy information; and expands the monitoring and evaluation framework with a commitment to use the information to make better decisions and report frequently on Program progress.”¹¹

Figure 1 provides a summary timeline of the changes described above. The following sections describe the contributions and progress on components of the four-part strategy described in the Council’s economic analysis paper;

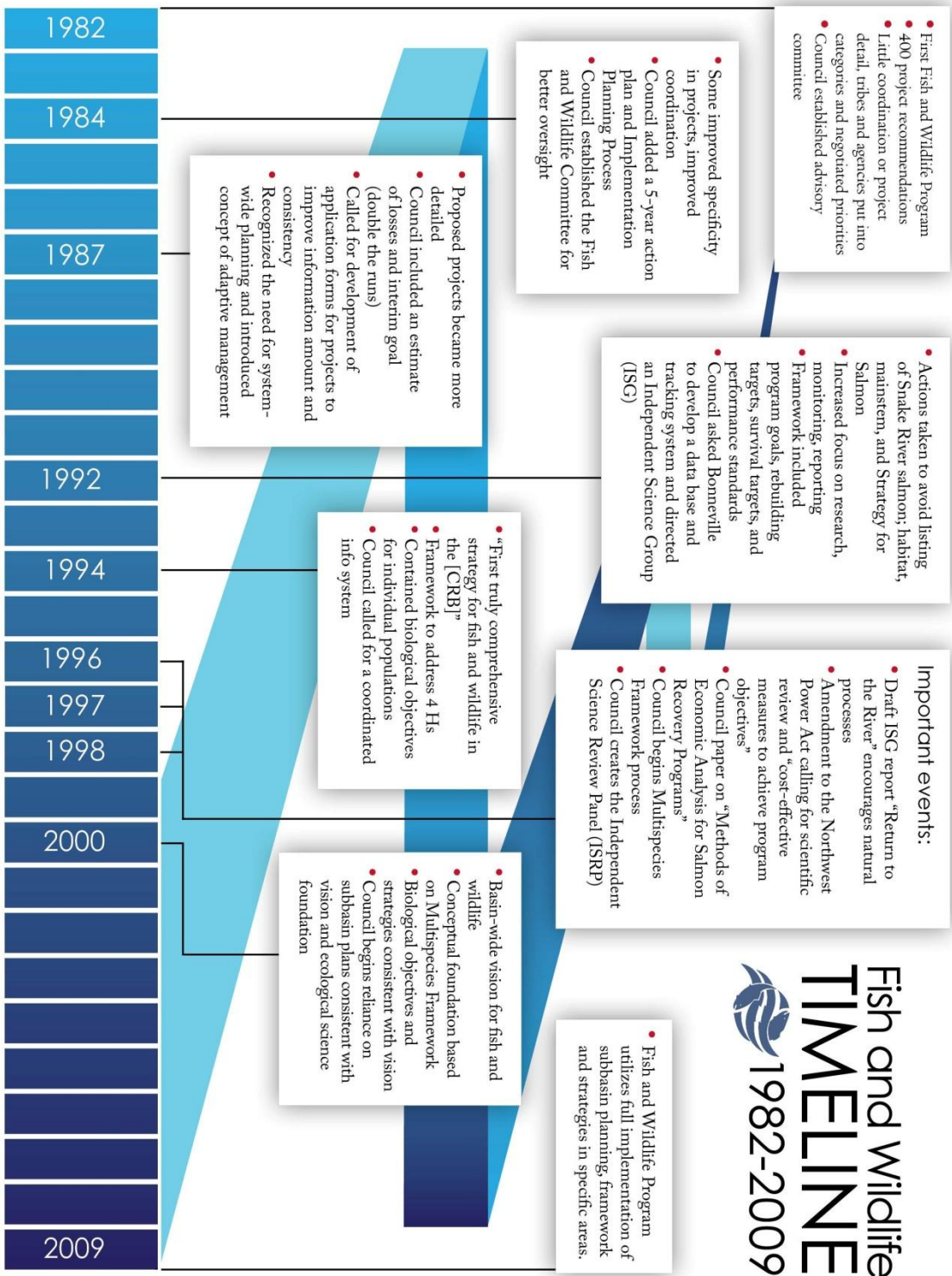
1. ensuring biological effectiveness through scientific review,
2. increased use of cost analysis in project selection and prioritization,
3. improved project management and accountability, and
4. better collection and review of data on project costs and accomplishments.

SCIENTIFIC REVIEW

Following the 1996 amendment of the Act, three independent science review boards were created by the Council. The Independent Scientific Review Panel (ISRP), which was a direct result of the 1996 amendment of the Act, reviews individual fish and wildlife projects funded by Bonneville Power Administration and makes recommendations on matters related to those projects. All projects proposed for Bonneville funding must be reviewed by the ISRP. The Independent Scientific Advisory Board (ISAB), which evolved from the ISG, serves the National Marine Fisheries Service (NOAA Fisheries), Columbia River Indian Tribes, and Northwest Power and Conservation Council by providing independent scientific advice and recommendations regarding scientific issues that relate to the respective agencies' fish and wildlife programs. The ISAB addresses broader programmatic and scientific issues that affect the program, rather than focusing on specific projects. Finally, the Independent Economic Analysis Board (IEAB) addresses issues of cost-effectiveness within the Fish and Wildlife Program. Each of these boards and their contributions are discussed in the sections that follow.

¹¹ (NPCC 2009). Page 5.

Figure 1: Timeline of Fish and Wildlife Program Evolution



The Independent Scientific Review Panel

The 1996 amendment to the Northwest Power Act (Act) required the [then] Northwest Power Planning Council (Council) to establish an eleven member Independent Scientific Review Panel (ISRP). The purpose of the ISRP is to provide the Council with independent scientific review of projects funded by the Bonneville Power Administration (Bonneville) (Northwest Power Act 1996).

The introduction of a formal independent review process represented a major change in the Fish and Wildlife Program (Program). Prior to 1995, Bonneville implemented the Program by selecting projects and contractors to implement specific Program measures. In 1995, Bonneville and the Council adopted a new process which required fish and wildlife managers to prioritize projects through an Annual Implementation Work Plan (AIWP) (ISRP 1997).

The ISRP has three major areas of review responsibility for the Council:

1. Review projects proposed for direct funding by Bonneville under the Council's Program.
2. Provide a retrospective review of previous-year project accomplishments to the Council.
3. Review fish and wildlife projects funded through the Bonneville's "reimbursable" program (federal agency projects reimbursed by Bonneville but not directly referenced in the Program) to determine consistency with Program criteria (NPCC 2011b).

ISRP Reviews and Cost-Effectiveness

The ISRP reviews projects proposed by project sponsors for direct funding through Bonneville's annual fish and wildlife budget in regard to whether they:

- are based on sound science principles;
- benefit fish and wildlife;
- have clearly defined objectives and outcomes; and
- have provisions for monitoring and evaluation of results.

Northwest Power Act language detailing review responsibilities of the ISRP and Council has ensured that the review process is transparent and well documented (NPCC 2011b).

ISRP reviews do not specifically evaluate project budgets but instead focus on a proposal's technical merits. From its inception, the ISRP also has made recommendations through its reviews to promote increased collaboration, monitoring and evaluation to improve research effectiveness and, indirectly, to reduce costs.

In the early years of the review process, the ISRP found project proposals to be generally inadequate for review, but significant efforts have led to substantial improvements in proposal quality over time. ISRP recommendations have resulted in actions to improve effectiveness and efficiency at project and programmatic levels, to avoid duplication, improve transparency and accountability, promote coordination and enhance learning from past actions.

A number of ISRP recommendations subsequently adopted by the Council enhance the cost-effectiveness of the Program (ISRP 1997; 1998; 1999; 2000a; 2000b; 2001; 2002; 2005). These include:

- Grouping of proposals by geographic area to assess how well projects were coordinated to address limiting factors of a given area;
- Development of category reviews that consider project interactions within subject areas;
- Standardization of proposal formats;
- Improvement of data reporting, information management and accounting systems to facilitate prioritization;
- Addition of a fix-it, or response, loop to allow project sponsors to respond to review comments and improve proposals;
- Provision of peer advice to project sponsors regarding scientific soundness, accountability, justification, methods, and monitoring and evaluation;
- Establishment of rolling multi-year reviews by geographic area with site visits, presentations, and response loops;
- Development of subbasin plans to provide better regional coordination in the identification of limiting factors and critical uncertainties;
- Improvements in and coordination among projects;
- Use of targeted solicitations to address critical uncertainties and information gaps (e.g. Chinook salmon mainstem habitat needs, population structure and genetic structure);
- Expansion of request for proposal distribution to increase Program competitiveness and enhance research project quality;
- Creation of a special funding category for innovative proposals to conduct “proof of concept” approaches to salmon recovery problems;
- Establishment of effectiveness reviews of ongoing programs, such as land and water transactions;
- Development of protocols to prioritize habitat acquisitions;
- Establishment of a three-step review process for artificial production projects to ensure continued consistency with goals and objectives of the Program;
- Creation of separate review processes for research and operations categories;
- Identification of questionable proposal budgets as areas for further scrutiny in funding decisions;
- Development of monitoring and evaluation protocols; and,
- Promotion of coordinated system-wide monitoring.

Scientific Review Process and Structure

The structure and process of project selection is a complex and dynamic system reflecting the diversity of interests involved. A good illustration of the complex structure and sequence of project selection as implemented from 2000-2005 is provided in the graphic on page 114 of the ISRP’s Retrospective Report 1997-2005 (ISRP 2005). An example of the current review structure and schedule is shown on page 9 of the Northwest Power and Conservation Council and Bonneville Power Administration’s (Bonneville) letter to project proponents for the Resident Fish, Data Management, and Regional Coordination Category Review (NPCC and Bonneville 2011).

Since the formation of the ISRP in 1996, the approach to scientific review has evolved to improve the efficiency and effectiveness of the proposal selection process. The basic structure of the review remains constant. The ISRP reviews proposals and programs on their technical merits and makes recommendations to the Council. The Council, working within statutory and programmatic frameworks, considers the ISRP recommendations in conjunction with comments from the project proponents, Bonneville, NOAA Fisheries, and the public. The Council makes final funding recommendations to the Bonneville, providing a written explanation where its recommendations to Bonneville diverge from those of the ISRP (ISRP 2005).

Bonneville funded research and actions fall into two categories: “expensed” and “capital” projects directly funded by Bonneville, and “reimbursable” projects sponsored by the Corps of Engineers and other “federal action agencies” whose hydrosystem related costs are reimbursed by Bonneville. The ISRP advises the Council on expense projects and is also required to annually review reimbursable projects to determine consistency with criteria specified for direct Program projects in the 1996 Amendment to the Northwest Power Act (ISRP 2005).

Bonneville must implement the Program in a manner consistent with the Council’s Fish and Wildlife Program (NWPA 1994), but may also conduct its own review of projects, identify other projects to be funded, or decide on appropriate levels of project funding (ISRP 2005). Bonneville actively engages with the Council in identifying and reviewing projects, and decides on appropriate budget levels and project contract amounts. Bonneville differs at times with Council project recommendations, but within a framework of overall Program consistency and with a requirement for a reasoned explanation in writing for any differences.

The Independent Scientific Advisory Board

The Independent Scientific Advisory Board (ISAB) was established in 1996 by the Northwest Power and Conservation Council and NOAA Fisheries to provide independent scientific advice and recommendations regarding scientific issues related to those agencies’ fish and wildlife programs. The Columbia River Indian Tribes (represented by the Columbia River Inter-Tribal Fish Commission) were added as a partner in oversight of the ISAB in 2002.

The purpose of the eleven-member ISAB is to foster a sound scientific approach to the recovery and research programs of NOAA Fisheries, the Council, and the Columbia River Tribes. These include the Council Program, tribal fish and wildlife programs, and the NOAA Fisheries salmonid recovery program (NPCC 2011a).

The ISAB works on general tasks guided by its work plan as well as specific tasks identified by ISAB sponsors. Major areas of responsibility include:

1. Evaluate scientific principles of the Program for consistency with best available science.
2. Evaluate the Program on its scientific merits in time to inform Program amendments.
3. Provide scientific review of NOAA Fisheries recovery planning activities for Columbia River Basin stocks.
4. Review scientific and technical issues associated with efforts to improve anadromous fish survival through all life stages.

5. Review and provide advice on priorities for conservation and recovery efforts, including research, monitoring, and evaluation and data management.
6. Review topics identified as critical to fish recovery and conservation in the Columbia River Basin.
7. Evaluate the scientific merits of plans and measures proposed to ensure satisfaction and continuation of tribal treaty fishing rights in the Columbia River Basin and other tribal efforts to restore and manage fish and wildlife resources.
8. Compare the various plans, strategies, analytical tools and methods employed by the Council, NOAA Fisheries, the Columbia River Basin Indian Tribes, and others related to the management of Columbia River Basin fish and wildlife to identify areas of consensus, disagreement, uncertainty, and opportunity (NPCC 2011a).

The ISAB evolved from two predecessor scientific review bodies. The six-member Scientific Review Group (SRG) was formed in 1989 through an MOU between Bonneville and the Columbia Basin Fish and Wildlife Authority (CBFWA) which acted on behalf of state, federal, and tribal fisheries managers. Guidelines were established to ensure SRG independence and objectivity. The SRG was charged with scientific review of projects and synthesis of broader scientific questions (ISG 1994; Williams 2006).

The SRG was followed by the Independent Scientific Group (ISG), established in 1995 in response to measure 3.2B.1 in the Council's 1994 Fish and Wildlife Program. The ISG was charged with conducting a biennial evaluation of the Program on its scientific merits, identifying specific key uncertainties with respect to the Program measures, and responding to questions submitted by the Council or raised during the implementation process. The latter included objective scientific advice on prioritizing and evaluating Program actions (Williams 2006).

ISAB Reviews and Cost Effectiveness

To date the ISAB has completed 74 reports covering a wide range of topics (ISAB 2011). The primary focus of the ISAB has been on issues of mainstem passage, but it has addressed a number of other Columbia River Basin problems of interest to its three institutional sponsors. A summary of ISAB work between 1996 and 2009 identifies four main categories of reports: state of the science reviews, the Council's Fish and Wildlife Program, NOAA Fisheries recovery science analyses, and Columbia River Indian Tribes' Programs (ISAB 2010). As with the ISRP reports, the focus of ISAB reports is on enhancing biological effectiveness; cost-effectiveness is not typically directly addressed.

State of the Science reviews: The Council's 2000 Fish and Wildlife Program directs the ISAB to develop a series of reports to survey past research and summarize the state of the science in key areas (Northwest Power and Conservation Council 2011a). The reports cover harvest, hatchery supplementation, tributary habitat recovery, flow augmentation, salmon recovery, modeling and analytical tools, climate change, human population growth, non-native species, fish tagging technology, landscape-scale restoration, and Columbia River food webs (ISAB 2010).

Council Fish and Wildlife Program: ISAB review of policies, principles and objectives of the various iterations of the Program have informed Program amendments and influenced Program

elements such as the multi-species framework, mainstem passage, artificial production and reservoir operations. In collaboration with the ISRP, the ISAB reviewed the subbasin plans developed to identify limiting factors and inform research needs throughout the Columbia River Basin. The ISAB also reviewed the Council's draft Research Plan designed to address critical uncertainties identified in earlier ISAB and ISRP reports, and more recently contributed to the development of field protocols and high-level indicators. The research plan, protocols and indicators are all intended to enhance Program effectiveness and efficiency (ISAB 2010).

NOAA Fisheries Recovery Science Analysis: The ISAB has reviewed analytical methods, models and indicators underlying NOAA Fisheries' recovery plans and biological opinions. It has also provided advice on the biological effects of recovery strategy choices such as in-river transportation versus spill, latent mortality, and passage (ISAB 2010).

Columbia River Indian Tribes' Programs: In 2009 the ISAB reviewed the draft Tribal Pacific Lamprey Restoration Plan for the Columbia River Basin and made recommendations for plan improvements and effective implementation (ISAB 2010).

The Independent Economic Analysis Board

The 1996 Northwest Power Act requires the Council to use cost-effectiveness evaluation in prioritizing measures within the Fish and Wildlife Program (Northwest Power Act 1996). This requirement is supported by the memorandum of agreement on Bonneville spending for fish and wildlife measures which underscores the importance of cost-effective fish and wildlife investments (NPCC 2007).

To address these requirements, the Council established the Independent Economic Analysis Board (IEAB) in November 1996. The purpose of the eight-member Board is to advise the Council on cost-effectiveness and other economic issues associated with the Fish and Wildlife Program as well as to apply economic analytical capability to the prioritization of fish recovery measures. IEAB members represent a variety of specialties within natural resource economics (NPCC 2007; NPCC 2011c).

The IEAB works on specific tasks within six major areas of advisory responsibility for the Council (NPCC 2007):

1. Advising on methods of economic analysis for alternative fish recovery measures;
2. Commenting on the appropriate role and limits of economic analysis;
3. Evaluating new analytical tools and advising on study designs;
4. Helping to identify sources of information and data;
5. Performing specific analytical tasks assigned by the Council;
6. Assisting in the review and interpretation of study results.

IEAB Reviews and Cost-Effectiveness

To date the IEAB has completed 30 reports covering a wide range of topics (IEAB 2011). The IEAB has focused on issues of cost-effectiveness, but has also addressed a number of other economic issues pertinent to the Council's Fish and Wildlife Program, including economic risk, economic impacts, project cost-accounting, project efficiency improvements, evaluation of tradeoffs, and economic feasibility (IEAB 2011).

Cost-effectiveness: The IEAB has evaluated issues of cost-effectiveness at the levels of both practice and projects. Practice-level cost-effectiveness assessments have addressed alternative strategies for fish and wildlife improvements (1997-2), preservation of wildlife habitat (2006-1; 2007-5), juvenile passage (2004-1), mainstem passage (2004-2), water acquisition (2001-1), and subbasin planning (2003-2). Project-level cost-effectiveness assessments have included Lower Snake River restoration (n.d.), in-stream water supply in Salmon Creek (2001-2), proposals for improvements in the Methow and Twisp Rivers, and the Select Area Fishery (2007-3).

Economic risk: The IEAB provided a framework for assessing the investment costs of invasive species prevention measures against the potential costs and risks of establishment of the invasive Zebra and Quagga mussels in the Columbia River Basin (2010-1).

Economic impacts: The IEAB reviewed the estimated economic impacts of recreational salmon fishing in Idaho and advised the Council on the quality of the analytical results (2005-2). The IEAB also assessed the economic effects within the Columbia River Basin of artificial production of salmon (2005-1) and advised on the interpretation of three local economic impact studies for Tri-cities ports, steelhead fishing and the restoration of salmon fishing in Idaho (1997-2). The IEAB reviewed a study by Save Our Wild Salmon on the effects of removing the Lower Snake River dams (2007-1) and served as the technical review team for the Economics Appendix I of the Corps of Engineers EIS on "Lower Snake River Juvenile Salmon Migration Feasibility Study" (2000-1).

Project cost—accounting: The IEAB reviewed existing practices of project cost-accounting within the Fish and Wildlife Program. The review identified options for improved project cost-accounting (2006-2) and recommended the application of consistent standards for project cost escalations (2007-2).

Project efficiency improvements: The IEAB has addressed efficiency improvement opportunities at both the programmatic and project levels. Programmatically, it identified areas of potential cost reductions through assessments of the economic components of hatchery operations (2002-1; 2009-2) as well as areas of potential reductions in operations and maintenance costs for wildlife projects (2007-4). At the project levels, economic reviews of specific proposed projects have identified areas of potential cost reductions (2002-2) or areas needing cost data and analysis (2005-8; 2007-3).

Evaluation of tradeoffs: One of the IEAB's earliest work tasks was a demonstration of how tradeoffs within the Fish and Wildlife Program could be evaluated (1999-1). The potential for using frameworks to assess economic tradeoffs was also assessed for subbasin planning (n.d.) and was later expanded to general planning within the Fish and Wildlife Program (2003-1) and interactions between the Fish and Wildlife Program and the Sixth Power Plan (2009-1; 2009-3).

Economic feasibility: The IEAB has reviewed and commented on economic feasibility analyses of Lower Snake River restoration (2000-1) and Columbia River mainstem passage (2004-2).

Water Transactions: Members of the IEAB provided guidance to contractors reviewing the Columbia Basin Water Transactions Program.

IMPROVED PROJECT MANAGEMENT AND ACCOUNTABILITY

Proposal guidance and forms

The proposal process for the Program has developed from a relatively simple and poorly documented process in the early years of the Council to a detailed, open and well-documented process. The development of the current proposal and reporting process is largely guided by the ISRP recommendations, as described in the sections above. The process requires detailed information about the objectives, methods, and accomplishments of funded projects. The management of this process involves proposal guidance documents and required forms and reporting formats for the funded projects. In addition, the retrospective assessments of project accomplishment by the ISRP, occurring periodically over the years, have contributed to the evolution of the written proposal and reporting requirements. A summary of the currently required proposal content is displayed in Table 1 below. A full description of the proposal instruction is online at the NPCC website.¹²

The individual project reviews conducted by the ISRP are based on the required progress reports from project managers. ISRP teams of at least three members review each proposal and supporting documents in the context of subbasin summaries and the Fish and Wildlife program.

The overall NPCC review process is now designed to include six steps: planning; project sponsors' reports and proposals, ISRP review; public review; staff review and recommendations, and final Council decision. A key step in the proposal review and evaluation process is ISRP review, assisted by members of a peer review group, resulting in evaluations and recommendations to the NPCC who then make recommendations to the Bonneville Power Administration.

To facilitate the management of hundreds of contracts over the past decade, Bonneville has funded the development of two data management systems that assemble information regarding the proposal and funded projects. The Pisces database was organized to facilitate management of the contracts issued to fund the projects. The basic organization is focused on the individual

¹² (<http://www.cbfish.org/Content/img/ProposalInstructions.pdf>).

contracts.¹³ The more recent Taurus database is organized to accumulate information at the broader project level.¹⁴ Taurus permits review of projects based on topic or region or other criteria, and enables systematic review of project objectives and accomplishments. The Taurus database is still in development and contains about half of the proposals considered by the Council since 2007.

Table 1: Summary of Instructions for Proposal Summary

Main Sections	Sub-Sections
Basics	<ul style="list-style-type: none"> • Proposal Short Description • Proposal Executive Summary
Summarize History	<ul style="list-style-type: none"> • Explanation of Recent Financial Performance • Explanation of Financial History • Explanation of Performance • Major Accomplishments • Response to past ISRP and Council Comments and recommendations • Adaptive management
Purpose	<ul style="list-style-type: none"> • Explain your project’s significance to Regional Programs
Objectives	<ul style="list-style-type: none"> • Problem Statement/Technical Background • Project Objectives • Objective Description
Relationship	<ul style="list-style-type: none"> • Geographic Region • Similar Work
Focal Species	<ul style="list-style-type: none"> • Other Focal Species • Emerging Limiting Factors
Work Type Details	<ul style="list-style-type: none"> • Add Hatchery Program • Research, Monitoring and Evaluation (RM&E) • Tagging
Deliveries/Budget	<ul style="list-style-type: none"> • Deliverable Description • Fiscal Year Budgets • Facilities/Equipment
Metrics/Methods	<ul style="list-style-type: none"> • Describe your Study Design
References	<ul style="list-style-type: none"> • Project References or Citations
Key Personnel	<ul style="list-style-type: none"> • Key Personnel

Source: from <http://www.cbfish.org/Content/img/ProposalInstructions.pdf> , accessed on 7-25-2011

¹³Available at - <http://efw.bpa.gov/contractors/usingpiscs.aspx>

¹⁴Available at -<http://www.cbfish.org/>)

Retrospective assessments

In addition to scientific review of individual fish and wildlife projects funded by Bonneville, the 1996 Amendment to the Northwest Power Act charges the ISRP with annual review of the achievements from prior year expenditures. The Council's 2000 Fish and Wildlife Program refined the retrospective review charge, stating that the ISRP's report should focus on measurable benefits to fish and wildlife due to Bonneville-funded projects.

In 1998, a U.S. Senate-House conference report added to this review task by directing the ISRP to annually review all fish and wildlife projects, programs, or measures included in federal agency budgets that are reimbursed by Bonneville. Many of those projects are not included in the Council's program. But the ISRP is to determine whether the proposals are consistent with the criteria specified for Program projects covered by the 1996 Amendment (see ISRP 2005-14, p. 107). The four major components of the reimbursable program include:

- Columbia River Fisheries Mitigation Program (Corps of Engineers)
- Fish and Wildlife Operations and Maintenance Budget (Corps of Engineers)
- Lower Snake River Compensation Plan (U.S. Fish and Wildlife Service)
- Leavenworth hatchery (Bureau of Reclamation)

Four broad retrospective reviews of Bonneville funded projects have been produced by the ISRP in 2005, 2007, 2008, and 2011 (ISRP documents 2005-14, 2007-1, 2008-4, and 2011-25). In recent years the ISRP has produced more narrowly focused retrospective reports; ISRP 2011-10 which reviews Columbia Basin habitat monitoring protocol, and ISRP document 2011-14 which reviews the Lower Snake River Compensation Plan Spring Chinook program. These retrospective assessments by the ISRP provide a useful record of the improvements and shortcomings in the information supplied in project proposals and in subsequent monitoring and evaluation of project results. Currently, the ISRP is working on another retrospective assessment.

INFORMATION SYSTEMS FOR PROJECT AND PROGRAM ASSESSMENT

The Program has funded and collaborated with other agency efforts to improve the quality of information about fish and wildlife mitigation and its costs. Since the inception of the Program there has been a growing body of data and information systems that provide improved information about the status of the fish stocks, production and harvest levels, fish and wildlife project information, habitat status, and other measures. The categories of information and data include project and Program management systems, documentation of project and Program actions and effects, and models to organize information and analyze various aspects of the program. In addition, models have been developed to aid the analysis of interactions between fish passage policy and hydropower system electricity production and costs.

In spite of growing numbers of data and information systems, the achievement of a comprehensive and integrated information system for fish and wildlife has been elusive. The available information resides in many different locations and cannot be easily used for comprehensive assessment of the Program.

Some of the data systems and models have been grouped below by main purpose. The list is not comprehensive and the descriptions are very brief, but they give an indication of the effort that has been put into developing information about fish and wildlife projects and their effects.

Data and Information

These sources have compiled important data about the status of fish and wildlife and their habitats in the region.

Northwest Hydrosite Database

The Northwest Hydrosite Database was developed in the early years of the Council's existence. It contains detailed information on some 4,500 existing, proposed and potential hydroelectric development sites. The database included over 400 parameters on individual projects or sites.

StreamNet

StreamNet provides access to fish and fisheries related data and reference documents in the Columbia River basin and the Pacific Northwest. The website is funded by the Program and administered by the Pacific States Marine Fisheries Commission (PSMFC). The project supports fisheries management agency staff to obtain georeference and standardize data. A variety of data are provided in tabular format and as maps and GIS layers. Information is available through the online database query, interactive maps, the Data Store, or by custom request.

Fish Passage Center

The Fish Passage Center (FPC) provides technical assistance and information to fish and wildlife agencies and tribes, in particular, and the public in general, on matters related to juvenile and adult salmon and steelhead passage through the mainstem hydropower system in the Columbia River Basin. The FPC provides data on fish numbers, and has specific responsibilities involving FCRPS operations and flows, survival and travel time estimates, fish transportation, dissolved gas trauma, adult fish passage, and hatchery releases.

Protected Areas Data Base

In an effort to preserve healthy habitat and limit further damage to fish and wildlife, the Council designated areas that should be protected from further development of hydroelectric facilities. Protected areas are listed in a database that can be easily referenced by potential developers who can then avoid the expense and effort of developing sites that are likely to be controversial and should not be pursued.

IBIS

The Interactive Biodiversity Information System (IBIS) contains information about wildlife and terrestrial habitat conditions in specific locations of the region.

Project Management

Project management tools are used to track the activities, schedules, costs and accomplishments of fish and wildlife projects.

Pisces

Pisces is a software tool created by Bonneville to help manage fish and wildlife projects. The purpose of Pisces is primarily for project tracking and management. Pisces allows project contractors and Bonneville project managers to create and manage statements of work based on standardized work elements. Work elements are associated with metrics that report how much is being accomplished. Pisces can help tie project milestones and deliverables to project budgets. Using Pisces, Bonneville is able to track over 28,000 distinct projects, gathering and reporting metrics, other effects, locations, schedules, focal species and many other data. This means that managers and oversight can determine where and how work is getting done.

The IEAB investigated Pisces in 2006, finding that “Pisces is a project management tool and is not designed for economic analysis. Pisces information will be helpful, but more detail will often be required for useful analysis. For most projects, some of the important cost, engineering, and site-specific information is not provided in the proposals or Pisces” (IEAB, 2006). After this report, Pisces was modified to address some of the IEABs’ concerns. In particular, Pisces now provides information about cost shares provided by sources other than the Program.

CBFWA

The Columbia Basin Fish and Wildlife Authority (CBFWA) maintains detailed information on fish and wildlife projects throughout the basin. In addition, they maintain information on the status of anadromous fish stocks in individual basins, which is readily available from the CBFWA website.

Program Management

Program-level management tools are oriented to aggregate measures of project activities and accomplishments.

Taurus

Taurus is the Columbia Basin Fish and Wildlife Program Projects and Portfolios website, cbfish.org, that provides information about the Program. Major categories of information are:

- Portfolios and Projects: provides access to the portfolio of projects, from 2007 on, designed to protect and rebuild fish and wildlife populations affected by federal hydropower development.
- Funds: Provides data about Program funding from 2004 on.
- Change Requests: Provides a way for project managers to submit a change request application and provides information about change requests to modify existing projects. Typical requests include extending the amount of time to complete work, changing the type of work, increasing budgets, or moving budgeted funds between fiscal years. A separate process is being used to request changes to Accord projects.
- Proposals: Provides information and access to help applicants submit proposals.
- Reviews: Provides access to past and ongoing reviews. Reviews are initiated at the request of the Council. They can be small and only involve one project and one fiscal year, or large, involving hundreds of projects over many years. A review is complete only when one of its scenarios is approved.

- Interactive Data & Reports, and Work Elements, Metrics & Measures: primarily data from Pisces but with more capability for mapping and organizing information.
- FCRPS BiOp: Provides access to the BiOp and Reasonable and Prudent Actions (RPAs)

Clearly parts of Taurus fall into the project management category, but its capabilities support broader Program analysis and comparisons as well.

ISEMP

One of the requirements of the adaptive management approach is careful monitoring and evaluation of Program effects. The Integrated Status and Effectiveness Monitoring Program (ISEMP) was created to develop protocols and new technologies, novel indicators, sample designs, analytical tools, data management, communication tools and skills, and restoration experiments to support the RME program. ISEMP contributions to ongoing decision-making include PIT tag detection technology, juvenile survival and growth estimation procedures, three Intensively Monitored Watersheds, basin-wide data management system development, data analysis tools development, and a habitat monitoring protocol and program.

Columbia Habitat Monitoring Program (CHaMP)

NOAA's CHaMP program will attempt to link data on habitat changes – flow, temperature, etc., -- with effects on fish. It would generate standardized status and trend data for salmonid habitat in watersheds of the Columbia River Basin with large juvenile survival gaps. The intent is to provide information for inferences regarding habitat quality and quantity at the fish population level that will be used in conjunction with salmonid growth, survival, abundance and productivity to estimate fish-habitat relationships across the Columbia River Basin. Data gathering for CHaMP is just getting underway, and some biologists believe it will take three or four generations of fish before meaningful conclusions can be drawn from the data. If successful, CHaMP relationships could help provide the missing link between habitat actions and their effects on fish.

IBIS

IBIS is an informational resource developed by the Northwest Habitat Institute (NHI) to promote the conservation of Northwest fish, wildlife, and their habitats through education and the distribution of timely, peer-reviewed scientific data. IBIS contains extensive information about Pacific Northwest fish, wildlife, and their habitats, but more noteworthy, IBIS attempts to reveal and analyze the relationships among these species and their habitats.

IBIS data is currently being refined and extended to include all of Idaho, Oregon, Washington, and the Columbia River Basin portions of Montana, Nevada, Utah and Wyoming. IBIS will eventually include species range maps, wildlife-habitat maps, extensive species-habitat data queries, and interactive wildlife-habitat mapping applications allowing dynamic spatial queries for the entire Pacific Northwest as previously defined.

Models

Modeling of the hydropower system, fish and wildlife habitat, and populations has been used to support analyses of Program projects and priorities.

EDT

The Ecosystem Diagnosis and Treatment, or EDT, is a system for rating the quality, quantity, and diversity of habitat along a stream, relative to the needs of a focal species. The methodology includes a conceptual framework and a set of modeling tools with which to organize information and rate habitat elements with regard to the focal species. EDT describes conditions in a stream based on the science of fish habitat needs. EDT can identify the potential for a stream under existing or modified conditions. Streams are broken out into segments to help identify priorities. The result is a scientifically based assessment of conditions and priorities for restoration. EDT has been used extensively in the Pacific Northwest for a number of years in a variety of settings. The method has substantially contributed to subbasin planning.

Genesys

Genesys ("Generation Evaluation System") is a computer model used to evaluate power supply adequacy in the Pacific Northwest. The model started in 1987 with the goal of providing an improved planning tool that incorporates the complexity and operation of the Northwest power system. Genesys is housed at the Council, with a version also used by Bonneville, and is used to evaluate the effects of mainstem fish and wildlife operations on the Northwest Power System. In addition, it is the tool that the Council used to assess the adequacy of the power system, and to simulate the effects of growing wind generation on the power system.

Compass

Compass is a model designed to simulate passage survival of juvenile salmonids downstream through the Columbia and Snake River dams. It is limited to Snake River stocks and passage at this point but is being expanded to address more of the salmon life cycle and more stocks.

Habitat Evaluation Procedure (HEP)

The Habitat Evaluation Procedure is an accounting system to combine habitat quantity and quality to determine the ability of habitat to support specific species of wildlife. It results in a measure of habitat units to indicate the value of habitat improvement actions for wildlife support potential. It has been used by Bonneville for wildlife habitat crediting.

Combined Habitat Assessment Protocols (CHAP)

The Combined Habitat Assessment Protocols or CHAP is an accounting and appraisal tool that is a simple, yet scientifically advanced, methodology used to measure habitat quality by evaluating biodiversity within a habitat type and/or structural condition. The outcome of a CHAP evaluation is a Habitat and Biodiversity (HAB) metric that gives a per acre value for each homogeneous polygon delineated. CHAP accounts for species-habitats-functions at a site that is also joined to a peer-review Integrated Habitat and Biodiversity Information System (IBIS) to create appraised "values" between site(s) and different management activities.

PROGRAMMATIC IMPROVEMENTS

Programmatic improvements are trends that have facilitated coordination and helped to develop and implement program-level priorities. Many of these have occurred in the past development of the Program and others are currently underway, in development, or being considered.

5-year work plans

The 1984 Fish and Wildlife Program added a 5-year work plan. This provided a mechanism for prioritizing project implementation so that the available money for the implementation could be directed to the most urgent and promising activities.

Subbasin Plans

Subbasin planning was initiated in the early 2000's to achieve a comprehensive, integrated and scientifically sound Fish and Wildlife Program through locally-developed plans, broad participation, and coordination with federal, state and local laws. A subbasin plan includes three parts: 1) an inventory of existing programs, activities and plans, 2) an assessment to determine the biological potential and opportunities for restoration, and 3) a management plan including a vision, biological objectives, and strategies.

Subbasin plans helped to ensure that projects address local, critical limiting factors in a systematic and prioritized way. Subbasin plans also help with prioritization of specific projects by providing a more comprehensive background against which to assess a project's contribution and role. Subbasin plans now form the backbone of the Program, while also building grassroots support by involving local people and organizations. This helps build consensus and identify potential funding and implementation partners.

The IEAB provided "Recommendations and Guidance for Economic Analysis in Subbasin Planning" in 2003. The report encouraged subbasin planners to provide a short section on cost-effectiveness analysis within the management plan. The intent was to encourage planners to consider alternative approaches to achieve subbasin goals that could make available money stretch farther.

Consolidated approach to RM&E

More recently, the Council has adopted an effort to improve research, monitoring, and evaluation (RM&E). The Draft Columbia River Basin Monitoring, Evaluation, Research and Reporting (MERR) Plan was drafted by Council staff during 2009 and 2010. The MERR Plan provides expectations for, and guidance on, how RM&E and reporting are conducted through the Program. The MERR Plan is an adaptive plan that intends to ensure that the Council's Columbia River Basin Fish and Wildlife Program (Program) goals, objectives, and actions are monitored, evaluated, and reported in a manner that allows assessment and reporting of Program progress.

The MERR Plan consists of a Strategic Plan, Implementation Framework, and Implementation Strategies. The Strategic Plan sets forth the purpose and expectations for RM&E and reporting implemented through the Program. The Implementation Framework contains existing, modified and new processes for prioritizing and implementing RM&E and reporting at the programmatic level. The Implementation Framework guides the development of standardized Implementation Strategies for anadromous fish, resident fish, and wildlife. The three Implementation Strategies, for anadromous fish, resident fish, and wildlife, are being developed with regional partners, and will consider integration of regional products to promote cost-effectiveness.

Refining Program Objectives

Many different objectives, some explicit and many implicit, are reflected in the Fish and Wildlife Program based on recommendations to amend the Program from tribes, states, federal agencies and others. Objectives may be biological, environmental or administrative in nature. The Council must give substantial deference to a recommendation from a tribe or state fish and wildlife agency. However, these objectives are not organized into a Program-wide set of objectives.

Because cost-effectiveness implies achieving an objective at the lowest cost, having a well specified objective or goal is important. The first interim goal for the Program, a goal of doubling the runs, was stated in 1987. Over the years some specificity was added to help assess progress and focus on how various actions might affect the components of a broader goal.

Currently the Council staff is attempting to develop a more specific set of objectives for the Program based on objectives contained in the subbasin plans. Over 9,000 individual objectives were extracted from the subbasin plans. The staff is consolidating these into a relatively small set of objectives for the overall Program. The intent is to identify about 20 Program objectives, which will help guide priorities and assess progress on a more systematic basis.

Categorical Review

As noted by NPCC in 2011: “Beginning in 2009, the Council and Bonneville, with advice from the ISRP, decided to review projects in functional categories (wildlife, monitoring, evaluation and research, artificial production, resident fish and blocked areas), to be followed by a review of certain projects, especially habitat actions, organized by subbasin and province. The central purpose of the categorical reviews is to highlight issues apparent only by looking at similar projects collectively, such as duplication and redundancy, relevance and relative priority, coordination, consistency of approach and methods and costs, and collective consistency with the broad basinwide objectives and strategies in the Fish and Wildlife Program.”¹⁵

The Council and ISRP have completed a categorical review of RM&E projects. Other categorical reviews will include resident fish/blocked areas, regional coordination, and data management. The purpose of the categorical review is illustrated by the following questions posed to the ISRP by the Council as guidance for the categorical review.¹⁶

- “Is the project scale and resource commitment appropriate for the project’s objectives?”
- For research projects, is a critical uncertainty being addressed? What is the hypothesis being tested, and is it prioritized in the Research Plan? The Fish and Wildlife Program and draft Monitoring, Evaluation, Research, and Reporting (MERR) Plan favor projects than can generate or develop tools to better inform management decisions and to deploy Program resources more efficiently.

¹⁵NPCC. 2011. Review of Research, Monitoring and Evaluation and Artificial Production Projects, Recommendations of the Council. June 2011 (with July 2011 addition of completed Part 4).

¹⁶ Letter from Council Chair Bruce Measure to Eric Loudenslager, Chair of the ISRP. July 15, 2010.

- Is the monitoring or research conducted by a project proportional to the biological risk or project success risk? For example, actions that have a high risk of negatively impacting fish or wildlife or have a high risk of not achieving their intended outcome may require a higher level of monitoring. On the other hand, tried-and-true projects that are generally considered lower risk, such as riparian fencing, riparian planting, and culvert replacement, may require less monitoring. This should not be interpreted as diminishing the Council's commitment to such lower-risk projects, but rather as acknowledging that differing levels of research, monitoring, and evaluation may be appropriate.
- Does the project contribute valuable data to inform one of the nine program-management questions from the working list proposed by the Council and the associated High Level Indicators? The nine proposed basinwide management questions and associated indicators are posted at: (http://www.nwcouncil.org/fw/program/hli/2009_10.htm). The Council is seeking data for these questions and indicators to help evaluate whether the Program is fulfilling its charge under the Act.
- What does the ISRP see as major accomplishments of these projects, and are the data derived from the projects useful and relevant? The Council has requested each project sponsor provide this information in a summary form with their project descriptions, and we ask that the ISRP evaluate their responses.
- Is the project part of a comprehensive monitoring program? Projects should not duplicate or be redundant with similar efforts elsewhere in the basin and should be designed to operate efficiently and in an integrated, cost-effective manner.
- Does the project fill a priority Program data gap, or is the project required by a biological opinion or a recovery plan for species listed under the Endangered Species Act? Data generated by the project should provide new information.
- Does the project's RM&E data have a reasonable certainty or a reasonable confidence level? For example, does the RM&E data meet the preponderance of evidence test? Project data should be designed and reported in a manner that can facilitate their use in adaptive management and guide policymakers in making good decisions related to the project's topic.
- Is the project consistent with the general principles of the Hatchery Scientific Review Group (HSRG)? Projects should 1) address the HSRG's scientific analysis to the extent to which the HSRG's recommendations are applicable to the project, and 2) be consistent with both the Program and strategies to protect wild fish. A project may use adequate alternative strategies to achieve the HSRG principles.
- Are data produced by the project fully described, including metadata and methodologies used, easily available for public review, and capable of being used to aggregate data to an appropriate higher scale, such as a broader geographic scale or population scale?

Projects also should facilitate sharing and reporting of their data with the public in an easily understandable and accessible manner.

- How should the Council consider the impact of ocean conditions on fish and wildlife populations in making its final recommendations to Bonneville?”

The IEAB views the categorical reviews as an important step in the development of cost-effectiveness analysis of the Program. Grouping projects by category invites comparative analysis of costs and accomplishments, and specific questions regarding efficiency have been posed.

High-Level Indicators

The Council is developing a set of “high-level indicators” to better assess the accomplishments of the Program. High-level indicators are a set of quantitative metrics selected to communicate the progress of the Program to the region's Governors and to Congress. While currently under public review, there are 17 high-level indicators that fall into two broad categories of indicators: biological and implementation.

Part II. Assessment of the potential for continued programmatic improvements

Part I documents how the cost-effectiveness of the Program has progressed over time. However, the IEAB believes that further improvements may be possible. The reason for this conclusion is not that inefficient expenditures have been observed. Rather, it is because the types of information needed to establish the potential for cost-effective changes are not routinely provided by the large array of information programs in the region. Two types of such information are highlighted below.

1. Cost-effectiveness analysis requires consideration of alternatives, and consideration of alternatives may happen implicitly and informally at many levels, but explicit efforts to identify and analyze the role and quality of alternatives are not well documented.

Identification and comparison of alternatives is an integral part of modern planning. Formal alternatives analysis is conducted under National Environmental Policy Act (NEPA) and other laws. Informal alternatives analysis might be much less detailed. For cost-effectiveness analysis, the appropriate attention to alternatives analysis might depend largely on the dollar amount of cost being contemplated.

Currently, proposals submitted for categorical review offer an opportunity for evaluation of alternatives. In the past, the proposal form solicited information on alternatives. Proposals are now required to contain information on the project's financial history, major accomplishments, management changes taken, and significance to regional programs. It would be possible to reinstate the requirement that information about alternative approaches be incorporated into the proposal, as the ISRP recommended after previous reviews (e.g., FY 07-09: proposals should include "discussion of alternative approaches and how these have been evaluated in deciding on a course of action.") (NPCC 2006a). Consideration of alternatives is also included in Step Reviews -- "All projects are expected to ensure that cost-effective alternate measures are not overlooked and include descriptions of alternatives for resolving the resource problem, including a description of other management activities in the subbasin, province and basin (Step 1)" (NPCC 2006). In the past, these recommendations and requests have not yielded detailed information and would likely require accompanying descriptive examples and feedback to ensure effective description of alternatives.

There have been few documented processes for identifying or developing alternatives (or options) that could provide a basis for comparison. For example, the ISRP's criteria for proposal review are sound science, benefits to fish and wildlife, clear articulation of desired outcomes, monitoring and evaluation, but not the development and comparison of alternatives. It is not clear to the IEAB that alternatives, and their costs, receive enough weight in the project selection process to ensure the funding of cost-effective projects. Therefore, one useful investigation would be to document when and how alternative ways of accomplishing project objectives have been considered.

2. Cost-effectiveness analysis requires quantified, physical measures of product (fish and wildlife) that are not currently available for most fish and wildlife projects;

For the IEAB, the main reason for lack of formal cost-effectiveness analysis has been a lack of biological measures of effectiveness. The Program has been shaped by extremely difficult and persistent information problems involving the status of fish populations and how they might be affected by specific actions. Indeed, a large share of the Program budget is directed to research, monitoring and evaluation with the ultimate goal of better understanding fish population dynamics and the effectiveness of remedial actions. There is a general inability to accurately assess the effect of individual projects on fish populations because the influence of multiple limiting factors is difficult to quantify.

In its 2011 Retrospective Report the ISRP summarizes accomplishments of approximately 150 Fish and Wildlife Program projects and the status of major basinwide programmatic issues in three key areas: 1) artificial production, 2) passage through mainstem dams, the river, and reservoirs, and 3) habitat restoration monitoring. The Report finds improvements in the monitoring and evaluation of all three areas. However, it also finds that a lack of a comprehensive analysis of biological achievements for hatcheries and habitats impedes the understanding of Program effectiveness.

There have been recent advances in quantitative estimates of biological benefits. Work required under the FCRPS BiOp has provided advances in quantifying benefits, in three or four ways. One is that measurement of juvenile survival through mainstem passage routes has improved. However, the jump from juvenile survival numbers to overall life-cycle survival is still tenuous.

Another breakthrough has been the effort that put quantitative survival estimates on suites of actions -- or on the biological potential in a particular life-stage -- in the Comprehensive Analysis for the BiOp. These numbers, arrived at as much by professional judgment as by hard data, are contested. But the simple exercise of developing the methods provides an opportunity for advances in cost-effectiveness comparisons.

A team dedicated to estuary science set up to plan and recommend implementation actions has taken the next step and developed quantitative estimates of survival benefits from individual actions or proposed projects. This needs to be vetted by the science boards, but the development and use of survival units and costs should allow for comparison of different actions in the estuary on a common cost-effectiveness currency. Next, we may ask whether it will be possible to take the overarching survival estimates in the other life-stages, especially in the tributaries, and put unit survival estimates on different actions that have identifiable costs.

Cost-effectiveness investigations could involve intermediate products that can be measured with some accuracy, such as those being measured by existing RM&E programs. Examples of intermediate products include, for habitat projects, amount of habitat and instream flow protected, and for hatcheries, numbers of juveniles produced. The IEAB has conducted studies involving both of these measures.

However, comparisons of seemingly identical measures of habitat or juveniles are quickly complicated by details, for example, the time of year when flow is protected is important for

salmonid survival. Different characteristics and purposes even within species complicate comparisons. One useful investigation might be to identify groups within species that can be viewed as being homogenous and therefore, subject to potential cost-efficiency comparisons within the group.

Flexibility and Range of Discretion in Council Funding Decisions

For cost-effectiveness analysis to be useful there must be alternatives that could actually be implemented. Even if the necessary information could be provided, the IEAB recognizes that the amount of discretion available to the Council in funding projects is limited, especially in the short run. There is limited flexibility for change.

The Council has limited influence on mainstem operations to enhance survival due to biological opinions, treaty, and other legal requirements. The ESA can mandate actions that effectively guide or even control Program actions. A major constraint on Council flexibility in project funding is the commitment of a large portion of the Bonneville budget to specific entities and actions. The 2008 Columbia Basin Fish Accords (Accords) are agreements among the Bonneville Power Administration (Bonneville), Corps of Engineers, and US Bureau of Reclamation (collectively, the “federal action agencies”), four Columbia River Basin tribes (Yakama, Umatilla, Warm Springs and Colvilles, and two states of Idaho and Montana in which Bonneville set aside \$917 million for a ten year funding period to support projects that would benefit fish affected by the Federal Columbia River Power System (FCRPS). There is also a very limited agreement, non-binding in nature, with the State of Washington to develop BiOp-supportive projects in the lower Columbia and Estuary. The focus is on actions to support the FCRPS BiOp, but non ESA-listed fish (especially lamprey) are also included (NPCC 2008; Bonneville 2008).

The 2008 FCRPS BiOp contains a number of Reasonable and Prudent Alternatives (RPAs) in support of salmon and steelhead listed under the Endangered Species Act. The RPAs include performance standards for survival of juvenile fish through the dams, timing of hydropower system spill and operations to benefit individual species, an expansion of the habitat program, expansion of predation-management, and commitments and timetables for hatchery consultations and reforms (Federal Caucus 2008).

Although the Accords and BiOp have led to increases in the total Bonneville expense budget, their net effect is to capture budget shares and significantly decrease the portion of the budget for actions taken outside these instruments. Taken together the Accords and BiOp now account for 79% of the Program budget. The 2009 Bonneville budget planning principles included separate budgets for the Accord, BiOp, and Uncategorized (non-BiOp and non-Accord) Program components. Budget shares were allocated as 43% to the FCRPS BiOp, 31% to the Accords, and 21% to Uncategorized (Delwiche 2008).¹⁷

¹⁷ Budget component type percentages for FY2009 do not add to 100 because they represent [approximate] target expenditure shares of a “not to exceed” total of \$200 million.

The multi-year implementation commitments represented in the Accords and the BiOp emphasize ESA-listed anadromous stocks and therefore cover many areas of the Council's Program. However, the Council has a broader obligation to implement its Program for the benefit of all fish and wildlife, including their spawning grounds and habitat that are affected by the Columbia hydropower system, (NPCC 2009). These areas have been addressed most recently through targeted solicitations in four categories: wildlife, artificial production, resident fish and RME (research, monitoring and evaluation.)

The fixed and small (21%) proportion of the budget not committed to projects through the BiOp and Accords leaves the Council with a limited range of discretion in project funding. Projects funded through the BiOp and Accords are subject to scientific review (NPCC 2008) but with committed funds these types of projects represent limited funding flexibility. The 2009 Fish and Wildlife Program explicitly recognized this reality in its focus on performance. The revised Program states that the Council will renew the emphasis on scientific review, increase reporting and accountability requirements, emphasize adaptive management, develop quantitative objectives, exchange science and policy information, and expand the monitoring and evaluation framework to be better able to assess Program progress.

One useful investigation would be to more fully document the range and timing of discretion in Council funding decisions given the constraints imposed by mandates, agreements, and contracts. Such an investigation might also help the Council identify opportunities to prioritize among fish and wildlife projects.

Project-Level Cost Effectiveness And Cost Management

Even where there is little discretion, or where population changes cannot be measured, cost-effectiveness improvements might involve cost management. The Council's 1996 cost-effectiveness paper suggested increased use of cost analysis in the selection and prioritization process and improved contract management of fish and wildlife projects. These suggestions have resulted in major improvements such as Pisces and Taurus.

Within the 2009 Program framework, the main avenue available to the Council to capture funding efficiencies is through project accountability, both in the proposal and reporting stages. The IEAB believes that more explicit and rigorous analysis of project costs within the project selection process might result in cost savings. On the other hand, the Council's ability to influence project costs may be limited by the Council's need to defer to agency and tribal recommendations, and the fact that the Council has no say over the purchasing policies of federal, state, local and tribal governments and NGOs. The policies of these agencies and the actions taken by Bonneville, Council staff and others to help control costs are not currently well-documented. One investigation would document the existing policies and practices of fish and wildlife agencies and tribes to help reduce costs at the project level, and would explore ways in which the Council could promote cost management.

The IEAB has, in the past, investigated project information with an eye towards measures that might be useful for cost-effectiveness. There are some deficiencies in routinely collected cost data that inhibit cost analysis. For example, projects do not report on the expected life of

investments. Without this information, the potential for reducing cost by switching to shorter or longer-lived investments cannot be considered.

One other approach to improved cost management would simply focus on programs or projects that are already viewed as being marginal. Council staff and other experts are involved with projects on a daily basis. Rather than investigate alternatives and cost management generally, these experts could identify specific projects that are discretionary and could be subject to alternatives analysis, or projects that are viewed as relatively ineffective could be identified. The economic analysis would focus on these projects. This approach has the advantage of directly addressing questionable projects, but it might also be viewed as unfair.

Cost Effectiveness Within Subbasins

Sub-basin planning is a foundation for habitat and hatchery planning in the Program. The NOAA FCRPS 2000 BiOp stated that “NOAA expects to rely heavily on NWPPC’s subbasin planning process for the identification of offsite habitat mitigation opportunities.” The plans identify limiting factors within the sub-basin, and management plans should include a three year and a 10 to 15 year budget. In 2003, the IEAB provided “Recommendations and Guidance for Economic Analysis in Subbasin Planning” which suggested that

“the management plan include a short section on cost-effectiveness analysis. This section should identify alternative projects or strategies that could achieve the same result. Cost-effectiveness analysis may be justified for these projects if the results and costs can be measured, and if the costs are large enough to justify the additional analysis.”

In one case, the Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan, an entire appendix was devoted to economics.

One potential investigation for the IEAB would be to review existing subbasin plans for information on costs, alternatives, and cost comparisons to see if and how cost-effectiveness considerations affected management plans. In the past, alternatives were compared largely on the basis of qualitative judgments as to how they addressed the identified limiting factors and were the most amenable to implementation. Additional guidance on developing and comparing alternatives might help in the future. This effort might expand on the earlier IEAB report regarding recommendations for economics in sub-basin planning.

Cost Effectiveness Across Subbasins

Cost-effectiveness across subbasins would pertain to situations where there is a targeted species that exists in more than one subbasin, and that the members of the species in different subbasins are somewhat interchangeable. While this is certainly the case for some species or runs, it may not be for others. People who live in each subbasin may have a strong preference for protecting all species in their subbasin equally. This is especially true for fish harvested by tribes who want

fish returned to their traditional fishing places. Still, there may be opportunities to produce fish and wildlife more efficiently by recognizing when populations are interchangeable.

Comparative advantage might suggest that, rather than enhancing all species in all basins equally, it may be cost-effective to specialize or at least prioritize. The logic of comparative advantage and specialization may be especially applicable to hatcheries. Cost studies might reveal where one hatchery has a comparative advantage over others, and investment plans might be staged accordingly. Such studies might be used to show how sub-basins or hatcheries can coordinate to achieve economies that cannot be achieved through subbasin-by-subbasin management.

Because of ecosystem complexities such as threshold effects, ecosystem linkages, and spatial connections of watersheds, benefits of conservation on different resource units such as subbasins are not independent of each other. These complexities suggest a system approach is needed when designing conservation policies that combine subbasins.

A threshold effect is present when a significant environmental improvement can be achieved only after conservation efforts reach a certain threshold. For example, to protect a coldwater fish species, stream temperature must be reduced below a certain level. Wu, Adams and Boggess (2000) analyzed the consequences of ignoring the threshold effect in the context of preservation of wild stocks of steelhead trout by habitat management. This analysis confirms the presence of threshold effects in habitat investments within the John Day River basin. The analysis suggests that allocation of funds according to typical allocation rules or guidelines will not be cost-effective in the presence of these threshold effects. For example, allocation of funds equally across two sub-basins within the basin would not yield equal payoff in terms of enhanced trout production. More striking is the finding that even within a relatively small sub-basin or stream, the benefits of habitat investments vary markedly, depending on the condition of surrounding habitat. These results, although exploratory in nature, point to the need to manage habitat and other conservation investments in ways that recognize the complexity of the system.

Efficient targeting of conservation efforts requires consideration of spatial linkages of ecosystems. Watanabe et al. (2003) explored the importance of spatial linkages in the targeting of conservation efforts in the upper Grande Ronde River Basin in Oregon. They found that the heterogeneous nature of riparian conditions and stream morphology must be considered to allocate restoration activities cost-effectively. Local restoration efforts may be enough to achieve small localized water quality improvements. However, as the desired water quality standard increases in geographic scope, the cumulative (longitudinal) effects become more important, and restoration efforts in more distant reaches may be more efficient than efforts near the point of monitoring. If the underlying objective is to increase fish populations, targeting conservation efforts based only on too-limited physical criteria such as water temperature may lead to substantial benefit losses.

In the presence of threshold effects and ecosystem linkages, conservation targeting might take a two-stage procedure. In the first stage, conservation funds are allocated among watersheds. In allocating funds among watersheds, the program manager should make sure that conservation

efforts are above the threshold levels before expanding to new watersheds. In the second stage, resources within each watershed are targeted for conservation.

Cost Effectiveness For Projects Affecting Multiple Species

Many actions target multiple species, but there are often trade-offs between species, as recent conflicts between sea lions and salmonids testify. A cost-effectiveness analysis for one species may give misleading results if other indirect consequences are ignored. For example, conservation efforts to protect a cold-water species by reducing stream water temperatures may affect warm-water fish species. In a case study of conservation programs for salmonid habitat restoration in the Pacific Northwest, Wu and Skelton-Groth (2002) analyze benefit losses when such ecosystem linkages are ignored. They found that for every 100 dollars gained from increasing the numbers of cold-water fish in Granite Creek in the John Day River Basin in Oregon, there were on average 4 speckled dace lost. Because speckled dace is not endangered or otherwise highly valued, the tradeoff favors the cold-water species. But, if the warm-water species was an endangered species, or a popular recreational fishery, the decision may not be as clear-cut. This example illustrates the limitations of using cost-effectiveness analysis when alternative actions have multiple consequences.

How can economics contribute to thinking about such tradeoffs? Are there opportunities to obtain more of all good things? Benefit-cost analysis is one option, but it requires putting a monetary value on all outcomes. In most situations a cost-effectiveness analysis should consider effects other than the target objective, both positive and negative. These effects often involve complex interactions among valuable species and their habitats.

In summary, management of habitat investments must recognize ecosystem complexities. There may be threshold effects, ecosystem linkages, and spatial connections that should affect investment decisions. The complexity of ecosystems like the Columbia Basin is an invitation for bio-economic models, but scientific uncertainty and costs of information are an impediment to useful applications. In the interim, more consideration of potential interactions between actions prescribed in plans at the sub-basin level, evolutionary significant unit (ESU) level, and the mainstem level is advised. In addition, multiple subbasin plans could also be reviewed to see where tradeoffs among subbasins are evident, to investigate potential for comparative advantage, and to see if interactions among subbasins might justify more or less effort. While challenges are daunting for efficient management of conservation investments, potential payoffs may be high when economic comparisons are used in the design of conservation programs (Wu and Boggess 1999).

Increased Coordination With Other Fish Recovery Efforts

The Program has limited control over many factors that affect fish and wildlife, and only some of these factors are even controlled by people. Harvest policies are not part of the Program, and the Council has limited say over mainstem passage policies. However, interactions among the four

H's are increasingly recognized as critical to the health and recovery of many species. Biological opinions and recovery plans increasingly require coordination among multiple jurisdictions.

One possible investigation would be simply to review the status of coordination whose merits are implied by existing plans and mandates. In particular, Program and non-program progress toward integration of the Biological opinion, recovery plans, HSRG hatchery and related harvest management, the fish accords, and habitat actions, could be reviewed. The IEAB views this work as primarily non-economic. This work could be discussed with the other advisory boards.

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