Independent Economic Analysis Board

Interactions between Fish and Wildlife Program and Sixth Power Plan (Phase I)

IEAB Task Number 138

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Executive Summary

This report describes some interactions between the Fish and Wildlife Program (FWP) and the Sixth Power Plan, suggests that some of these interactions be considered in the Power Plan, and discusses additional analyses that may be appropriate.

Mainstem operations for fish in the Federal Columbia River Power System (FCRPS) under the recent Biological Opinions (BiOp) have been extensively documented in the form of hydrosystem, and power generation and value models. This paper does not focus on these models and their results. Rather, this paper identifies potential changes over the 20-year Power Plan time horizon relative to recent conditions and analyzes some other, less-studied interactions.

The IEAB concludes that several important interactions between the power system and the FWP should be analyzed and discussed in the Sixth Power Plan:

- Three changes in power supply and its cost will have demand and supply effects that will influence the amount, mix and costs of power. First, under the 2008 BiOp, increased FWP costs relative to the 2004 BiOp will increase BPA power prices. Increased prices can be expected to reduce quantity demanded. Second, in the next five years, new temporary spillway weirs (TSWs) may change the required amount and cost of fish spill relative to 2008 BiOp calculations at three FCRPS facilities. Third, there is still uncertainty about the amount of spill that will be required in the future; some spill levels are still being litigated. These three effects are inexorably linked and should be evaluated with other economic factors to determine the net effect on power sales and price.
- Mainstem operations for fish inhibit hydrosystem flexibility and increase the costs of integrating wind power and other variable output renewables into the power system. Conversely, any FWP actions that reduce the amount of required spill, or allow for greater flexibility of hydropower operations, enhance the usefulness and value of hydropower for wind integration.
- New water management plans and storage facilities could affect power use and generation because of shifts in the hydrograph, increased surface evaporation, increased water consumption by irrigated agriculture, and use of power for distributing and pressurizing irrigation water.
- Terrestrial and wetland habitat protection and restoration funded by the FWP may create opportunities to develop carbon credits which might be used to offset the carbon footprint of thermal power supplies.

Interactions that may not need analysis but should be acknowledged in the Power Plan are:

- Projects implemented under the FWP are expected to improve fish survival and productivity. Some other habitat changes associated with land development and climate change are likely to be unfavorable. Potential effects on fish spill and its costs can not be predicted.
- The FWP is investing in juvenile survival research which may resolve long-standing scientific issues and lead to changes in mainstem operations.

- Changes in hatchery operations can have small and locally significant effects on power operations, primarily through bypass spill. In the long run, the Hatchery Scientific Review Group (HSRG) recommendations could affect juvenile bypass operations.
- Decommissioning of some existing hydropower facilities is expected, but power losses are small relative to the amount of power use in the region.
- Changes in the agricultural economy will have important effects on land and water use and on incentives for participation in some voluntary Fish and Wildlife programs, all of which could affect electricity use for irrigation pumping and water available for hydropower.
- Financial pressures caused by FWP expenses could reduce or delay power facility maintenance and repair activities that support the efficiency of the FCRPS, but this interaction is currently regarded as unlikely.

Interactions that are judged to be less important are:

- Habitat improvements will not have a noticeable effect on the hydrograph at FCRPS facilities

Introduction

The Northwest Power and Conservation Council (Council) is required to produce a Sixth Power Plan by 2009 that incorporates the Council's Fish and Wildlife Program (FWP) and addresses interactions between the Power Plan and the FWP. Some of these interactions involve economics. This report provides a preliminary assessment of interactions between the Council's power planning and the FWP in terms of their relative importance to power economics and to the region.

One well-recognized link between power and fish and wildlife is reduced hydropower generation from mainstem operations at Snake/Columbia River dams designed to protect resident and anadromous fish, most listed under the Endangered Species Act (ESA). These operations include spill, flow, storage and temperature operations.

The economic costs of mainstem operations are routinely estimated using hydrosystem and power generation and value models including Genesys and Aurora. These models are run over a defined hydrologic period with an underlying level of development. Results are commonly expressed in terms of average annual difference in hydrology, generation, or electricity value where the difference compares two versions of the ESA Federal Columbia River Power System (FCRPS) biological opinion (BiOp). Below, we use the 2004 BiOp and the 2008 BiOp as reference conditions. The Power Plan, on the other hand, requires a 20 year planning horizon. During this time, many factors are expected to change. Therefore, it is important to consider what changes might be expected and how mainstem operations costs may change relative to the 2008 BiOp.

This paper first discusses some incremental impacts of the 2008 FCRPS BiOp and the Columbia River Fish Accords in terms of power generation and prices. Then, we consider other possible relationships between mainstem operations and improvements, FWP costs, and power use and production and consider whether they are worthy of additional analysis. For example, will increases in power prices caused by the FWP reduce power use? Will mainstem improvements reduce fish spill and increase generation? Will increased power values make habitat enhancement more cost effective than spill? Can FWP projects enhance fish numbers to the point where less spill is required? Might habitat work modify the hydrograph in ways that benefit hydropower? Will FWP expenditures decrease the availability of funds for power system maintenance and improvements? Could changes in hatchery and harvest management affect hydropower generation?

The paper also addresses the potential for emerging carbon offset markets and other environmental credit markets to benefit both the Pacific Northwest (PNW) regional energy system and its fish and wildlife. The new Power Plan will address the carbon footprint of the region's power system, and there may be a need to offset increased emissions by acquiring carbon credits. At the same time, BPA is tasked with mitigating habitat losses resulting from the construction of the federal Columbia River power system (FCRPS). Many of BPA's habitat acquisition and enhancement projects undoubtedly result in increased carbon sequestration. The question for the IEAB was: can the need to manage the carbon footprint on the power side be matched up with the carbon sequestration on the fish and wildlife side in ways that will benefit the region?

Other possible interactions concern the integration of emerging generating technologies such as wind and solar into the northwest power grid. Wind turbines provide power only when the wind blows and solar varies with the sun's intensity, so either the power system must fill in the gaps using other sources such as hydropower or gas turbines, or more demand management is required. If hydropower is called on to fill a major portion of these gaps, the more variable operations will have consequences for fish and wildlife. However, mandates to protect fish and wildlife may place constraints on the use of hydropower for wind power integration. The addition of wind power may increase the opportunity cost of some hydropower operations for fish and wildlife. Pump-storage systems have potential for addressing the power problem, but would entail other fish and wildlife consequences.

A number of proposed water storage and irrigation water supply projects would affect habitat, electricity demand and regional power generation. Some projects are being touted at least in part for their positive effects on fish. Examples include storage projects in the headwaters of the Snake River which would help assure the availability of Idaho's 427 KAF Water Budget obligation. Another example is the proposal to use Columbia River water to enhance fish flows in the Yakima River. In both cases the increased irrigation water use would affect both electricity demand and downstream hydropower generation.

This paper also examines how changes in the agricultural economy and policies affect the FWP and power. What effects do crop prices and changes in USDA land conservation programs (many of which have fish and wildlife implications) have on USDA program participation and what consequences will this have for hydropower generation and irrigation electricity demand?

1. Potential interactions between mainstem operation and other fish and wildlife activities

It is well recognized that changes in mainstem operations to protect fish and wildlife (especially spill to enhance the passage of listed fish stocks) results in reduced hydropower generation at Snake/Columbia River dams. This linkage has been extensively studied[1], and this task did not attempt any additional analysis. However, there are a number of recent changes and related interactions that may deserve more attention.

a. What will be the impacts of the recent FCRPS 2008 BiOp and the Columbia River Fish Accords on power generation and FWP costs?

Relative to the recent past, the 2008 FCRPS BiOp and the Columbia River Fish Accords between BPA, tribes and States will increase the amount that BPA spends annually on fish and wildlife projects by about $90 million as soon as 2010.[2] In addition, an annual average loss of 20 MW of

[1] Independent Science Advisory Board, Snake River Spill – Transport Review, September 16, 2008, ISAB document 2008-5, http://www.nwcouncil.org/library/isab/isab2008-5.htm

[2] Columbia Basin Bulletin. 2008. BPA Expects To Increase Fish And Wildlife Spending By 55 Percent FY2009-2011. Posted on Friday, September 19.

generation relative to the 2004 BiOp is expected to be worth an average of about $15 million annually.[3] These changes will increase the price that consumers pay for power in the region. The price increases could cause quantity demanded to be reduced and power supplies from other sources to increase. This potential is discussed in the next section.

Mainstem operations are expensive in terms of lost power production and replacement power purchased, with an annual average cost of roughly $350 million in recent years relative to pre-Power Act conditions.[4] The value of hydropower lost to spill has increased in recent years as the incremental cost of new replacement generation in the region has increased. As noted below, the flexibility of the hydropower system makes it especially valuable as the region integrates an increasing amount of wind generation into the system.

b. Will FWP costs increase electricity prices and reduce demand?

It is likely that most of the $90 million increase in FWP costs will be factored into the electricity system costs that BPA uses to set rates. Preliminary analysis at the time the MOU was first announced indicated that BPA wholesale rates would have to increase by 5 percent to cover this cost increase.[5] Retail rates should increase by about half of this amount or 2.5 percent.[6] The quantity of electricity consumed tends to be inversely related to price. Economists express this relationship as the “price elasticity” – the percent change in quantity divided by the percent change in price. Electricity price elasticity in the short term is about -0.1 to -0.3, and in the long term about -0.5 to -0.8. Thus the 5 percent increase in BPA wholesale prices caused by the $90 million FWP cost increase would result in a 0.25 to 0.75 percent decrease in the quantity of electricity demanded in the short run at the retail level and a 1.25 to 2.0 percent decrease in the long run. The June 2008 Final Resource Adequacy Assessment projects 2013 net demand of 23,625 average megawatts (MWa) [7], so the expected price increase could reduce demand by 59 to 177 MWa in the short run and 295 to 472 MWa in the long run.

We consider the reduction in quantity of demand for BPA power from the price increase to be an important economic interaction between the fish and wildlife program and power that should be acknowledged and developed further for the Sixth Power Plan. In particular, this effect should be analyzed simultaneously with other supply effects. Information on demand response by sector and supply response would provide useful detail.

c. How will mainstem passage improvements affect power production?[8]

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[3] Ruff, Jim and John Fazio. 2008. Memorandum to Council Members. Subject: Updated Analysis of the NMFS Final 2008 FCRPS Biological Opinion. Northwest Power and Conservation Council. July 11.

[4] Bonneville Power Administration Fact Sheet, Cost and rate impacts of Columbia Basin Fish Accords and the 2008 FCRPS BiOp, June 2008, http://www.bpa.gov/corporate/pubs/fact_sheets/08fs/Cost-and-rate-impacts-of-Columbia-Basin-Fish-Accords-2008-FCRPS-BiOp.pdf. The cost is very sensitive to annual water conditions and market power prices.

[5] The 5% is based on a rates rule of thumb that $70 million increase in revenue requirements would increase rates by $1 per megawatt-hour, not on a detailed analysis.

[6] As a general rule of thumb retail rates will only increase by half the increase in BPA wholesale power.

[7] NWPCC. 2008. Final Resource Adequacy Assessment. June.

[8] John Fazio and Jim Ruff, Council staff provided text revisions to help characterize the state of information about spill and RSWs in this section.

A number of mainstem projects will be implemented in the near future that could affect power production. The ISAB lists these recent and projected mainstem improvements.[9]

Removable Spillway Weirs (RSW)

- Lower Granite Dam: operational spring 2002 (First tested Sept. 2001)
- Ice Harbor Dam: operational spring 2005
- Lower Monumental Dam: operational spring 2008

Temporary Spillway Weirs (TSW)

- McNary Dam: operational spring 2007
- John Day Dam: operational spring 2008
- Little Goose Dam: projected for spring 2009

Extended Spillway Wall

- The Dalles Dam: operational spring 2004
- The Dalles Dam: new larger wall projected for spring 2010

The Dalles Dam Juvenile Fish Passage Project includes a spillwall which should increase juvenile survival, but no change in power production is anticipated.[10] The removable and temporary spillway weirs, on the other hand, have the potential to reduce spill and increase power production directly. In 2004, the IEAB assumed that RSWs could reduce bypass spill by half.[11] More recent data, however, seems to indicate that this level of spill reduction is not a realistic assumption.

Genesys runs for the 2008 BiOp included reduced spill from the RSWs at Lower Granite, Ice Harbor, and Lower Monumental.[12] The TSWs at John Day and McNary are still being tested. Spill reductions at those projects were not included in the 2008 BiOp runs. In addition, the Little Goose TSW is expected to be operational by 2009. Additional power savings may be realized at these projects, but until the performance of the surface passage systems can be evaluated and proven, these savings will not be reliable. At this time, Council staff advises that any estimates of spill reductions afforded by installation of surface bypass systems beyond those modeled are speculative.

Although the new TSWs should reduce the costs of bypass spill, other factors could work to increase spill and its costs. There is still uncertainty about the amount of spill that will be

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[9] Independent Scientific Advisory Board. 2008. Snake River Spill-Transport Review. A Scientific Review of Seasonal Variation in the Benefit of Transportation of Smolts from Four Snake River Evolutionary Significant Units (Spring/Summer Chinook, Steelhead, Sockeye, and Fall Chinook). For the Northwest Power and Conservation Council, Columbia River Basin Indian Tribes, and National Marine Fisheries Service September 16, ISAB 2008-5, Portland.

[10] CBB. 2008. Corps Moves Forward On Multi-Million Dollar Dalles Dam Juvenile Fish Passage Project Posted on Friday, May 16.

[11] IEAB 2004. Juvenile Passage Cost Effectiveness Analysis for the Columbia River Basin: Description and Preliminary Analysis. Document IEAB 2004-1. January.

[12] Ruff, Jim and John Fazio. 2008. Presentation to IEAB December 8 2008.

required in the future. Spill levels at mainstem federal dams are still being litigated. Additional court-ordered spill requirements could result in additional loss of generation.
In the Council's Fifth Power Plan, an assumption was made that over a 20-year period, hydroelectric generation would decrease by 450 average megawatts. This assumption was made based on the historical trends related to fish and wildlife constraints being placed on hydroelectric operations including bypass spill.

Currently, Council staff recognize that hydroelectric generation may continue to decline, but on the other hand, there is a possibility that hydroelectric generation may increase. If spillway weirs prove to be more efficient than anticipated, hydroelectric generation could conceivably increase and may offset some of the expected decline. The difficulty is in assessing the likelihood of either additional bypass spill or of efficiency improvements to bypass systems. For the Sixth Power Plan the staff is in the process of assessing potential reductions (or increases) to hydroelectric production over time.

Taken together, the additional FWP costs, TSWs and new spill mandates could have supply and demand effects that will influence the amount, mix and costs of power. The IEAB considers this to be an important economic interaction between the FWP and power that should be acknowledged and developed further for the Sixth Power Plan.

Sensitivity analysis is used to inform decision-making under uncertainty by showing how results change with changes in assumptions about the future. The IEAB suggests that the Power Plan include information about the relative effects of increased FWP costs, new TSWs, and changes in BiOp spill requirements on power production and value. This might be accomplished with back-of-the-envelope type calculations or more detailed simulation modeling might be justified where preliminary assessment suggests that a change has large effects and is not unlikely.

d. Will mainstem passage and other improvements increase survival to the point that less spill will be required?

Mainstem, habitat, hatchery and other improvements could eventually affect power production by improving survival and increasing the pace of recovery. If survival and passage goals are being met, then could power production be increased by reducing spill? The ISAB recently found that "Preliminary results suggest that recent structural and operational changes have improved the survival of in-river migrating spring/summer Chinook, steelhead, and sockeye, but a more complete answer to this question must await return of surviving adults and the calculation of SARs."[13] Council staff report that mainstem improvements and changes in the 2008 BiOp should significantly improve juvenile survival.[14]

Even if some populations increase, the potential for reduced spill as a result is not dependable. First, some populations are far from the recovery levels that would allow for reduced spill. Second, many uncontrolled factors such as climate change, land development and ocean conditions could work to inhibit recovery even if FWP expenditures and changes to mainstem operations are successful.

[13] ISAB. 2008. Snake River Spill-Transport Review. September 16, ISAB 2008-5, Portland.
[14] Ruff and Fazio. 2008.

In the long run, if the changes in mainstem operations and additional spending are successful in substantially improving productivity and survival of listed fish stocks within the 20-year time horizon of the Sixth Power Plan, then there would be potential to change mainstem operations to increase hydropower production and increase hydropower system flexibility. The IEAB has found that it may be possible to increase both power production and fish survival by using increased revenue from reduced fish spill to fund changes in habitat, hatcheries or harvest.[15]

Currently, because of juvenile survival issues (delayed mortality in particular), fish transport and bypass operations can not be unambiguously optimized. The FWP is investing in juvenile survival research which may resolve long-standing scientific issues and lead to changes in mainstem operations. A resolution of juvenile survival science should allow for changes that increase survival and/or reduce spill costs. Clearly, the Power Plan should mention the importance of juvenile survival issues and suggest how power planning might be improved if these issues were resolved.

e. Will increases in hydropower values make habitat enhancement more cost-effective than spill?

If the marginal value or price of power increases it may be cost-effective to reduce spill and spend the savings on other improvements. The IEAB compared survival from spill and mainstem improvements and found that some mainstem improvements could increase survival and power benefits, but the answer depended substantially on uncertain survival parameters; again, delayed mortality.[16] For other habitat improvements, it is unlikely that spill could be reduced as a direct result of the improvements for these reasons. First, ESA BiOps and recovery plans are biologically driven and tend not to address cost-effective substitutions. Second, the biological relation between habitat and fish numbers is not well-documented at present, weakening any argument that habitat, harvest or hatchery practices could be substituted for mainstem operations and making it impossible to develop a biological or economic analysis of this relationship.

Innovative biological modeling approaches such as that used in the Lewis River Case Study[17] suggest that it may be possible in the future to model these relationships. If these biological models prove generally acceptable to biologists, then this will provide the biological information required by economists to estimate the cost effectiveness of spill versus the cost effectiveness of habitat improvement in protecting/recovering listed stocks. The relative cost effectiveness of these alternative strategies depends on the value of the hydropower lost to spill, on the costs of habitat projects, and on the biological effects of spill and habitat.

In the short run this is not a significant issue for the Sixth Power Plan. However, if the biological modeling becomes more definitive within the 20-year time horizon covered by the Sixth Power

[15] IEAB 2004. Juvenile Passage Cost Effectiveness Analysis for the Columbia River Basin: Description and Preliminary Analysis. Document IEAB 2004-1. January.
[16] Ibid.
[17] Steel, E. Ashley, et al, Lewis River Case Study Final Report: A decision-support tool for assessing watershed-scale habitat recovery strategies for ESA-listed salmonids, May 2007, http://www.nwfsc.noaa.gov/research/divisions/ec/wpg/documents/lrcs/LewisRiverCaseStudyFinalReport.pdf

Plan, then the potential tradeoffs between spill and habitat investments could become a more significant issue.

f. Might habitat improvement projects modify the hydrograph in ways that benefit hydropower?

Some projects of the type being undertaken to enhance habitat for fish and wildlife have the potential to alter stream hydrographs. Projects that return streams to a natural profile, restore or enhance wetlands, reach agreement with farmers to leave more water in the river at times critical to fish, or modify vegetation for the benefit of wildlife all have a potential to affect the amount and timing of streamflow. In many cases these projects will, and many are specifically designed to, enhance streamflows in late summer, a time when water is especially valuable for both fish and hydropower.

While some habitat improvement projects probably have a significant effect on the local hydrograph, this interaction is probably not very important to the larger basin because most habitat improvement projects are situated far from hydropower facilities, are often separated by non-project facilities, and the quantity of flow shifting caused by habitat projects is often small relative to the entire hydrograph.

g. Will fish and wildlife program expenditures decrease the availability of funds for power system maintenance and improvements?

BPA, in an effort to contain costs, might try to pay for FWP costs by reducing spending on power system maintenance and improvements. This could reduce total generation below the potential of the hydropower system, as well as damage the system's efficiency and flexibility. For example, BPA budgetary pressures in the late 1990s resulted in cutbacks in conservation spending and delays in transmission system maintenance. To the extent that hydropower system maintenance and improvements are fish friendly, deferring these expenditures would offset some of the fish benefits of the fish and wildlife spending.

While it is true that appropriations for maintenance and improvements are provided independently of those for fish and wildlife, both are ultimately products of political and legal processes. The pressure to keep BPA rates low is real, so the additional $90 million fish and wildlife spending could cause pressure on other BPA spending. This interaction, though unlikely, should be acknowledged in the Sixth Power Plan.

h. Could changes in hatchery management affect hydropower generation?

There may be instances in which hatchery practices can be changed in ways that will affect spill and thus hydropower generation. An example of this is the recent changes at Spring Creek National Fish Hatchery located just above Bonneville Dam.[18] Since the early 1990s the hatchery managers have released juvenile Tule fall Chinook from Spring Creek in March, and asked the Corps to provide early spill for these fish prior to the start of the regular spill period in April. The

[18] The Columbia Basin Bulletin, Hatchery Production Shift Allows Higher Value Harvest Above Bonneville, Less Spill, October 24, 2008, http://www.cbbulletin.com/300493.aspx

recent action moved part of the Tule stocks to Bonneville State Fish Hatchery, below Bonneville Dam. The remaining Tule stocks at Spring Creek will be retained to grow to a larger size and released after the start of the regular spill period. The payoff will be a reduction in March spill at Bonneville, worth about $2 million per year in power revenues while maintaining Tule fall Chinook production.[19] In addition, the freed-up capacity at Spring Creek will allow for increased production of more valuable bright fall Chinook above Bonneville.

The Hatchery Scientific Review Group (HSRG) has been directed by Congress to recommend changes to hatcheries in the Basin to improve natural production. To date, the HSRG has produced summary reports for hatcheries by species in the Lower Columbia Basin, and elsewhere, draft population reviews by species and river. A cursory review of this information has not revealed recommendations that could directly alter hydrosystem power production or change power demands. However, there is potential for changes in timing and location of hatchery production to affect the timing and cost of spill. The possibility that hatchery management could interact with power production should be acknowledged in the Sixth Power Plan and the HSRG recommendations might be reviewed with this in mind.

2. The potential role of environmental credit markets in power planning and fish and wildlife programs

Bonneville Power Administration's Wildlife Mitigation Program, which was developed to offset the impacts of the dams on wildlife caused by the development of the FCRPS, has protected approximately 300,000 acres of land. Activities under this program include "land acquisition and management, habitat restoration and improvement, weed control, fencing, and other wildlife conservation actions."[20] In addition to protecting habitat these activities may generate other benefits, such as increased water flow and carbon sequestration, that could potentially be sold in established markets for environmental services.

The Council and BPA currently support an environmental credit market: the Columbia Basin Water Transaction Program (CBWTP). CBWTP provides funding and technical assistance to qualified local entities in their effort to protect instream flow to support threatened and endangered anadromous and resident fish species. This market-based approach to protecting flow was recently reviewed by Hardner and Gullison [21] who concluded that CBWTP "has been successful in developing a market for instream water."

BPA started collecting information in 2007 about the water rights on properties acquired under the wildlife mitigation program. These water rights could be permanently dedicated to protect instream flows in Oregon and Idaho or sold to generate revenue to support the Council and BPA's programs.

[19] ibid.
[20] Bonneville Power Administration, Division of Fish and Wildlife. 2008. Wildlife Crediting for BPA's Fish and Wildlife Program (October 13).
[21] Hardner, Jared and R.E. Gullison. 2007. Independent External Evaluation of The Columbia Basin Water Transactions Program (2003-2006) (October 7).

Activities taken under the wildlife mitigation program, such as changes in land management, habitat restoration, and habitat improvement, have the potential to sequester carbon[22] which could offset the carbon dioxide footprint of the Northwest Power System.[23, 24]

Oregon has an established program based on this approach -- The Oregon Forest Resource Trust. This program, which was established in 1993 by the Oregon Legislature, received $1.5 million dollars from the Klamath Cogeneration Project to offset carbon dioxide emissions. Money from the trust is used to fund reforestation projects on "[u]nderproducing lands…that once had forests, or are capable of growing forests, but [are] currently not occupied by a manageable stand of trees or seedings"[25]. Participating landowners "release their rights to the carbon dioxide emission reduction offsets accruing to the newly established forest. The State Forester can then market these offsets as a means to raise additional funds for the Forest Resource Trust. Landowners choose when and if to harvest and if there is no harvest after 200 years the forest is free and clear of the trust contract."[26]

Chelan PUD is listed as an "offset provider" on the Chicago Climate Exchange, the "world's first and North America's only active voluntary, legally binding integrated trading system to reduce emissions of all six major greenhouse gases (GHGs), with offset projects worldwide."[27] A memo summarizing Chelan PUD's approach (dated July 31, 2008), a 1-page document titled "Chicago Climate Exchange Proposal: December 17, 2007," and a PowerPoint presentation "Chicago Climate Exchange" presented by Suzanne Grassell and Tracy Yount from Chelan County PUD detail how offsets were generated.[28]

Chelan County PUD has increased hydropower production over a baseline level set in 1999 through its investments in energy efficiency improvements and environmental programs. The incremental power came from "1) equipment efficiency improvements such as those achieved from project modernization; and 2) operational efficiency improvements such as reduced spill due to the use of the fish bypass system at Rocky Reach Dam."[29] Importantly, funds raised through the sale of offsets will be "used to support and enhance Chelan PUD's environmental, conservation and efficiency improvement programs, all of which work to reduce the regions reliance on greenhouse gas-emitting power sources."[30]

This is a potentially significant opportunity deserving of further study. Several key issues would need to be addressed in any Phase II project. First, in collaboration with the ISAB, current scientific studies on the relationship between changes in land use and carbon sequestration

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[22] Cathcart, James F. 2000. Carbon Sequestration – A Working Example in Oregon *Journal of Forestry* 98(9): 32-37.
[23] Northwest Power Conservation Council. 2007. Carbon Dioxide Footprint of the Northwest Power System NPCC Document 2007-15 (November).
[24] Independent Science Advisory Board. 2007. Climate Change Impacts on Columbia River Basin Fish and Wildlife ISAB Document 2007-2 (May 11).
[25] Oregon Department of Forestry. 2008. Forest Resource Trust Program. (August 7).
[26] Oregon Department of Forestry. 2008, op cit.
[27] Chicago Climate Exchange. 2007. Overview (http://www.chicagoclimatex.com/content.jsf?id=821)
[28] Morlan, Terry. 2008. Presentation by Chelan PUD on Membership in Chicago Climate Exchange (July 31).
[29] Chelan PUD. 2007. Chicago Climate Exchange Proposal (December 17).
[30] Ibid.

should be addressed to determine if these benefits are sufficiently quantifiable to meet the requirements of the carbon trading market. Second, a decision is needed as to whether environmental services generated through the wildlife mitigation program can be separated from the program goal of generating habitat units. Additionality has been a key issue in the development of offset policies for greenhouse gas emissions. Non-profits, such as the Portland-based Climate Trust, have developed detailed criteria for evaluating whether a project generates benefits that are above and beyond what is required by "existing law, policy, statute or other regulatory framework." [31] This complexity suggests that managing the sale of carbon offsets may involve additional costs above those for the habitat mitigation projects themselves.

The potential opportunities for integrating fish and wildlife projects and carbon crediting should be developed further and acknowledged in the power plan. In particular, what new habitat projects are likely to be funded and how many carbon offsets could they generate?

3. Possible linkages between integration of emerging electricity generation technologies and fish and wildlife projects

The installed PNW wind generation capacity has increased from 25 MW in 1998 to 2,353 MW in 2007. The Northwest Power and Conservation Council's 2007 Wind Integration Report [32] indicated that wind generation capacity is likely to increase to nearly 3,800 MW by 2009. The report also indicated that the flexibility of the hydropower system is a major factor in the region's ability to integrate this wind power into the electric power grid. Wind turbines only generate power when the wind blows, resulting in a long term capacity factor of about 30%. However, when the wind is calm, as it often is during PNW periods of extreme hot and cold weather, the wind system's contribution to peak generation may be as low as 3 to 5 % of installed wind capacity. In these periods, demand must be satisfied from other sources such as natural gas combustion turbines or hydropower or demand management options must be implemented. Furthermore, wind conditions often change quickly, sometimes in minutes, so other resources must be able to adjust quickly to utilize the variable and unpredictable wind.

The growth of wind power places a growing premium on hydropower's ability to respond quickly and flexibly to fill the generation void left by becalmed wind turbines. Fish and wildlife operations, however, generally place a premium on stable water flows and stable hydropower generation. If flows are too low because the wind is blowing and the hydro system is holding back water, this hampers fish passage at the dams and through the slack water reservoirs. On the other hand, if natural river flows are high, and wind power is abundant, then either some wind turbines must be shut down, or some water must be spilled as the hydro system is cut back to match load, raising the risk of gas super-saturation below the dams.

Under the most recent BiOp, when the power grid comes under extreme stress, BPA has the option of declaring a "power emergency". Under these conditions, BPA has the ability to take actions to preserve the integrity of the power system, which might include elimination of spill,

[31] Climate Trust. nd. Open Solicitation Additionality & Baseline Guidance. http://www.climatetrust.org/solicitations_Open_Additionality.php
[32] http://www.nwcouncil.org/energy/Wind/library/2007-1.pdf

modification to flows for fish bypass facilities, or flow modifications that result in exceeding dissolved gas standards. Obviously a power emergency could be quite damaging to listed fish stocks. Maintaining hydropower system flexibility is extremely valuable if it helps avoid power emergencies and consequent damages to fish stocks.

Because the growing wind generation capacity places an increasing stress on flexibility of the hydropower system, and hence an increasing value on that flexibility, this suggests that FWP planning should pay increased attention to its effects on hydropower system flexibility. If habitat projects or improved fish passage facilities could lessen reliance on spill, then this might contribute positively to hydropower system flexibility.

Note that the linkages between wind integration and fish and wildlife operations go both ways. Fish and wildlife concerns place restrictions on the flexibility of the hydropower system, and changes in the hydropower system may affect fish and wildlife. More aggressive flow fluctuations could affect fish passage, fish rearing and nutrition, and fish stranding. However, fish and wildlife requirements are a pretty hard constraint on the hydro system.

Solar electricity generation is not yet commonplace in the BPA service area. Technological progress is decreasing the cost of solar generation, and increasing penetration is likely, especially in distributed applications such as residential and commercial rooftops. As this happens, BPA will face problems integrating solar into its grid that are similar to the problems of wind.

The Council's Wind Integration report mentioned pumped storage as one possible way to enhance system flexibility. Currently the Coulee – Banks Lake pumps are the major example of pump storage capability in the BPA region. (In fact, these pumps are identified as one way that BPA would respond to a power emergency.) The proposed Black Rock project has also been suggested as a site for pump storage. Aggressive use of pump storage would be expected to have downstream fish impacts – perhaps most significantly in the Hanford Reach where juvenile salmonids are subject to stranding by fluctuating flows.

This nexus of emerging generation technologies and the relationship to the existing hydropower system and its flexibility is an important issue and should be discussed in the Sixth Power Plan. In particular, what generation resources can provide the type of flexibility needed to accommodate renewable generation resources, and could mainstem operations play a role?

4. Potential impacts of proposed water storage projects on power supply and fish and wildlife

There has recently been a flurry of interest in new water storage projects in the Pacific Northwest. A sampling of these proposed water projects is listed in the appendix to this report. There are a number of reasons behind this recent interest including strong crop prices; full and sometimes over-appropriation of available water in some river basins; problems with inadequate water supplies during recent drought periods; concerns over the possible effects of climate change on water supplies; and the need to provide water for fish and wildlife including listed fish stocks. A report by Steven Malloch for the Bullitt Foundation, "Damned Dams: New Water

Storage for a Sustainable West" [33] outlines some of the reasons for the surge of storage proposals.

While many proponents claim that the proposed projects have fish and wildlife benefits, it is not likely that they would be a part of the Council's FWP. However, they may affect fish and wildlife productivity or survival, they may also affect the results of some BPA-funded projects, and they may affect power use and generation, so we include them in this report.

All of these proposed water storage projects would have impacts on the timing and quantity of river flows, and thus would impact the hydropower system. If the project provides water for new irrigation or firms up water supplies for existing irrigation in dry years, then consumptive use increases and downstream flow is reduced. Any new reservoir will also consume water through surface evaporation – about 3 to 5 acre feet per year for each acre of reservoir surface – adding to consumptive losses. The timing of flow reductions will depend on the operation of the project. Most new storage projects would be expected to refill using "excess" spring and early summer flows, so any reduction in hydropower generation would be concentrated at that time. Some of the projects have the potential to generate significant amounts of hydropower at the new dams, but many projects would also consume large amounts of electricity to distribute and pressurize irrigation water.

It is unclear whether any of the new dams and reservoirs listed below will ever be constructed. The federal government ceased financing and building big dams in the 1970s, and state and private entities have been generally unable or unwilling to finance such projects. Farmers' enthusiasm for new irrigation projects will be closely related to crop prices, production costs and the portion of project costs they are expected to bear. Finally, in an era when some dams are being removed for environmental and economic reasons, proposals to build new dams are highly controversial.

However some alterations to upriver water management are almost certain to occur. These include the already approved increased diversions and consumptive use of water from Lake Roosevelt, and probably some additional groundwater recharge in the upper Snake and Umatilla basins. These alone could have significant effects on downstream hydropower generation, and on electricity use for irrigation pumping. These potential effects should be acknowledged and discussed in the power plan. Additional investigation might determine which new management or storage projects are likely to advance and their effects on the hydrosystem.

5. Potential impacts of dam removal on power supply and fish and wildlife

Recent years have seen a number of existing storage and diversion dams removed in the Pacific Northwest. These dam removal projects typically have several characteristics. First, the dams are typically small and old, often built in the early 1900s, and often technologically outdated. Second, the impetus for removing the dams is generally fish. Often the dams were built without fish ladders and thus block fish migration. Removal of these dams can open up additional river

[33] Malloch, Steven, August 24, 2006, "Damned Dams: New Water Storage for a Sustainable West, The Bullitt Foundation, http://cbwtp.org/jsp/cbwtp/library/documents/Damned%20Dams%20-%20PDF%20Version%5D1.pdf

miles to salmonid spawning and rearing. Dams recently removed or proposed for removal in the region include:

1. Milltown Dam at the confluence of the Clark Fork and Blackfoot Rivers near Missoula, Montana, was built in 1908. It had a rated capacity of 3.2 MW, but in recent years generally produced 2.4 to 2.5 MW. The dam was removed in 2008.

2. The Bull Run Hydropower Project, consisting of Marmot Dam on the Sandy River in Oregon and Little Sandy Dam on the Little Sandy River, was built between 1906 and 1913. The dams, operated by Portland General Electric, had a capacity of 21 MW, and an average generation of about 13 MW. Marmot Dam was removed in fall 2007, and decommissioning of Little Sandy Dam was under way in the fall of 2008.

3. Condit Dam was completed in 1913 on the White Salmon River in Washington, and was part of the Pacificorp system. The 125 foot dam was built without fish ladders, so it blocked salmon access to the upper White Salmon, which previously had major salmon runs. Condit's rated capacity is 14.7 MW. A FERC relicensing process proposed a number of dam upgrades, including fish ladders. Pacificorp has proposed instead to decommission the dam. Controversy over the pros and cons of decommissioning has delayed the permitting process. PacifiCorp is hopeful that it can obtain final permits in time to allow dam removal to commence in October 2009.

4. The Elwha River dams include Elwha Dam, completed in 1913 just downstream from the present Olympic National Park, and Glines Dam, completed in 1926 within the present boundaries of the park. The rated capacity at Glines is 13.1 MW and at Elwha is 14.7 MW. The dams were built without fish passage facilities on what had been a major fish-producing river. Removal of the two dams is expected by 2012.

While the dams listed above are all non-federal dams, their removal will still affect the supply/demand balance for the region, which must concern BPA. Note however that the nameplate capacity of the dams listed above totals just 67 MW, compared to the 20,460 MW total capacity at the federal dams in the region. Thus the decommissioned and about to be decommissioned dams within the BPA service area total only 0.3 % of BPA's hydropower generating capacity. Unless substantially larger dams were to be proposed for removal within the time horizon of the Sixth Power Plan, dam decommissioning is not likely to be a relevant linkage between power supplies and fish and wildlife planning. Dam removals could have benefits for certain ESUs, but the potential for FCRPS spill and power production to be affected is uncertain at best.

6. Other changes in irrigation water use that may affect power supplies and the Fish and Wildlife Program

Irrigated agriculture has undergone many changes in the last few years. Perhaps the most significant is the 2007/08 escalation of crop prices attributable to the weak dollar, large amounts of grain being used as feedstock for fuel ethanol production, and production problems in some major producer countries.

Increased crop prices reduced farmers' participation in federal conservation programs administered by the USDA. Compared to 2007, the 2008 participation by Washington, Idaho and Oregon in the various Conservation Reserve Programs dropped from 2,953,279 to 2,876,222 acres.[34] [35] This drop of 2.6 percent was concentrated in Idaho. Some farmers willingly paid penalties to be released from conservation reserve contracts so they could raise crops instead.

Some of the federal land conservation programs are directly intended to benefit fish and wildlife habitat. In a recent report the IEAB proposed that the Council make more use of UDSA conservation programs in its FWP.[36] The recent pattern of withdrawal of land from these programs and slow rates of program signups could have an impact on fish and wildlife. Increases in irrigated cropland will increase irrigation water use, and will result in some decrease in downstream flows and hydropower generation. Since much of this land involves at least some electric pumping the increased crop acreage means more irrigation electricity use.

It is very difficult to predict what the future may hold for crop prices and for federal land conservation programs. Crop prices are increasingly set in international markets and large price swings are associated with international currency conditions. The use of grains as feedstock for fuel alcohol has come in for recent criticism, and efforts to shift to cellulose fermentation methods could radically change the situation. Weaker commodity prices in the fall of 2008 and escalating production costs suggest that conservation programs may be more attractive in the future. The potential effects of changes in the agricultural economy on power demand and fish and wildlife should be acknowledged in the power plan.

7. Other possible interactions

The IEAB discussed several other interactions but was not able to provide an opinion about their potential significance.

- FERC re-licensing of non-federal facilities could affect power production and habitat conditions.
- Wind generation could have effects on bird and bat species which are also affected by the FWP.
- Thermal power generation could affect fish populations by entrainment at cooling water diversions.

More analysis of these potential interactions could be provided in a Phase II of this work.

[34] http://www.fsa.usda.gov/Internet/FSA_File/crptable07.pdf
[35] http://www.fsa.usda.gov/Internet/FSA_File/enroll.pdf
[36] Independent Economic Analysis Board, A Scoping Investigation of Approaches to Preserving Habitat, June 5, 2006, IEAB document 2006-1, http://www.nwppc.org/library/ieab/ieab2006-1.htm

Appendix: Proposed Water Projects in the Pacific Northwest

Idaho:

Minidoka Dam enlargement. Minidoka Dam is located east of Burley and Rupert on the Snake River in southern Idaho. The dam was completed in 1906 by the Bureau of Reclamation. The dam spillway requires work, and it has been suggested that at the same time as the spillway work, 5 feet be added to the height of the dam to increase its storage capacity by about 50,000 acre feet. In 2008 the Idaho Legislature passed a joint resolution[37, 38] requesting that the federal and Idaho water agencies begin studies of the proposed Minidoka enlargement. The Bureau of Reclamation is in the early stages of such a study. The stored water (presumably water "surplus" to flow and storage refill rights in Idaho) would go mostly to irrigated agriculture, relieving some of the over-appropriation of ground and surface water supplies in that area, although it might also have some benefits for municipal and industrial uses and for meeting Idaho's commitment to the 427 kaf fish water budget.

Teton Dam replacement. The first Teton Dam was built in the early 1970s on the Teton River in southeast Idaho. The dam failed catastrophically during initial filling in 1976. The joint resolution passed by the Idaho legislature included the request that federal and Idaho water agencies study the possibility of replacing Teton Dam. The Idaho legislature has committed $1.8 million to start the studies of the Minidoka and Teton projects. The proposed concrete dam would store as much as 300,000 acre feet of water, to be used for irrigation and flood control.

Twin Springs Dam. The proposed Twin Springs Dam was also mentioned in the Idaho joint resolution. It would be located on the Boise River in southwest Idaho, and would store as much as 300,000 acre feet. The dam has been promoted for years by irrigation interests as a way to provide more water for municipal and industrial use in the fast growing Boise area, without the necessity of moving water away from irrigation use. The dam would also provide significant flood protection for low lying areas along the Boise River through Boise and Eagle. The flood control purpose seems likely to draw more support for the dam proposal, compared to the lukewarm support that the municipal/industrial/irrigation purpose has attracted.

Galloway Dam, to be located on the Weiser River in southwest Idaho, was also included in the Idaho joint resolution. The proposed 300 foot dam could store as much as 900,000 acre feet. The reservoir would provide significant flood control benefits. One reason why the 50 year old idea of building Galloway has recently resurfaced is the fish water budget. A large part of the water that Idaho currently provides for the fish budget comes from drawing down Cascade Reservoir, a water body that is heavily used for recreation. Galloway could provide that water without drawing down Cascade.

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[37] House Journal of the Idaho Legislature, February 8, 2008, http://www.legislature.idaho.gov/sessioninfo/2008/Journals/hday33.pdf

[38] Idaho Statesman, March 20, 2008, Lawmakers have their eye on new dams, higher dams http://www.idahostatesman.com/273/story/328597.html

The proposal to enlarge **Swan Falls Dam** was not among the projects mentioned in the Idaho joint resolution, but the proposal has emerged from the resulting discussion. Swan Falls Dam, on the Snake River in southwestern Idaho, was one of the first hydropower dams built in Idaho. The proposal would raise the dam by 50 feet, increasing its storage by 340,000 acre feet. The water could serve fish needs, as well as municipal, industrial and irrigation purposes.

Upper Snake groundwater recharge is presently occurring on a pilot basis. The idea is to use "surplus water" to recharge the Snake River Basin Aquifer, which is presently over-appropriated and declining. Methods tried include turning water into unlined irrigation canals during the non-irrigation season, and flooding water into selected recharge basins. In effect, the aquifer serves as a storage reservoir, without the problem that surface reservoirs have with surface evaporation.

Oregon:

The Oregon Governor's "Headwaters to Ocean (H2O)" [39] strategy is designed to meet future water needs through a three-pronged approach, one of which includes investing in new water storage and supply projects along with the development of more efficient water use and better conservation practices.

The strategy includes a number of items that relate to water storage and aquifer recharge:

- Recharge depleted aquifers to sustain existing agricultural and community use.
- Secure adequate in-stream flows for fish, wildlife and recreation.
- Develop and capture available winter water.
- Encourage feasibility studies and identify potential storage opportunities.
- Construct necessary infrastructure, including aquifer storage and recovery sites and off-stream surface storage reservoirs with adequate environmental protections.
- Minimize the effects of loss of snowpack, related to climate change.

The strategy also includes partnerships and strategic capital investments that will: 1. support a statewide program of grants to communities to engage in pre-design, final design, feasibility studies and financial administration of water storage projects; 2. Provide a state cost-share for water storage projects where there are benefits to the public as a whole. These projects are estimated to have biennial costs of over $20M.

In November 2007 Oregon Governor Ted Kulongoski addressed the need for water storage in the Umatilla Basin[40] at a meeting with Oregon tribal leaders. At that meeting the Governor outlined his objective to evaluate the feasibility of building large water storage areas in eastern Oregon to provide water for fish and irrigation and to insure against lower snowpacks associated with climate change.

[39] http://governor.oregon.gov/Gov/GNRO/may2008-h2o-strategy-comments.shtml

[40] http://oregonwatercoalition.org/2007/11/06/governor-suggests-possible-dam-water-bank-in-eastern-oregon/

Subsequently, a bill introduced at the February 2008 special legislative session was passed by the Senate Environment and Natural Resources Committee. Senate Bill 1069, the Agriculture and Community Water Act (ACWA), includes programs and projects that fall within the H2O strategy. It establishes a matching grants program for Oregon communities to fund feasibility studies for water conservation, reuse, and storage. It also authorizes projects designed to address ground water in the Umatilla Basin, including a water mitigation bank and a feasibility analysis of the Sand Hollow project, which would direct surface water from the Columbia and Umatilla Rivers into the Umatilla Basin during winter months to recharge depleted aquifers[41]. The bill was subsequently passed by the full legislature and signed into law. The project to evaluate the feasibility of a Umatilla Basin Aquifer Recovery Project was funded by the Oregon Water Resources Department in April 2008[42]. The project will assess the hydrologic, biological and economic feasibility of Umatilla Basin aquifer recovery.

Washington:

Black Rock Reservoir is one of several alternatives that the Bureau of Reclamation has looked at in the Yakima River Basin Water Storage Feasibility Study[43]. The Black Rock project involves a proposal to construct an 800,000 to 1,300,000 acre-foot storage reservoir in eastern Yakima County. The proposed reservoir would be filled with water pumped from the Priest Rapids Dam pool of the Columbia River, when such water is available in excess of current instream flow targets. Water from the reservoir would be used by participating irrigation entities within portions of the lower Yakima Basin in exchange for water currently diverted by those entities from the Yakima River under existing water rights. Yakima River water freed-up by this exchange would be used to achieve a number of objectives established by the Bureau of Reclamation under congressional authorization including:

- Improve anadromous fish habitat by leaving more water instream and creating more normative flows in the Yakima River;
- Improve reliability of water supply for proratable irrigation districts; and
- Assist in meeting growth in demand for municipal water supply.

The Bureau's draft EIS [44], issued in January 2008, concluded that the Black Rock project was technically feasible, but that is had a benefit/cost ratio of 0.16 making it economically infeasible.

Crab Creek Reservoir would be 137 to 236 feet high and would have a storage capacity of 1.3 million acre feet. Advocates have proposed Crab Creek [45] as a source of water for irrigators in the Columbia Basin Project, especially for groundwater users in the Odessa area where the rapidly declining Odessa Aquifer threatens to dry up presently irrigated farmland. Advocates claim that the reservoir storage could augment Columbia flows in drought period for the benefit

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[41] Oregon Senate Majority Office News Release February 11, 2008
[42] Columbia Basin Bulletin April 18, 2008.
[43] http://www.usbr.gov/pn/programs/storage_study/index.html
[44] http://www.usbr.gov/pn/programs/storage_study/reports/eis/index.html
[45] Information on the Crab Creek proposal can be found at http://www.americanrivers.org/site/DocServer/Meeting_Eastern_WA_s_Water_Needs_for_People_and_Fish_Ame.pdf?docID=7801

of listed fish, but critics argue that it would block and inundate critical habitat for threatened upper Columbia River steelhead and would inundate large tracts of wetlands and federal and state wildlife refuge land.

A program of **additional Lake Roosevelt drawdowns** is being implemented by the Washington State Department of Ecology [46]. One motivation for the drawdown is to address the declining aquifer problems in the Odessa area. Some 10,000 acres of Odessa lands will receive Lake Roosevelt water to replace groundwater. In addition, 379 holders of "interruptible" water rights will receive 33,000 acre feet of dry year water, assuring their water supplies; 128 municipal and industrial water right applicants will receive water; and 27,500 acre feet of water will be available to augment instream flows for fish each year and an additional 17,000 acre feet in dry years.

[46] http://www.ecy.wa.gov/pubs/0711051.pdf.