Recommendations related to amendments for the 2014 Fish and Wildlife Program

Independent Economic Analysis Board

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Overview

The Independent Economic Analysis Board (IEAB) provides economic advice and analysis on issues related to the Council's Fish and Wildlife Program. In this task, the IEAB provides an economic perspective on the future of the Fish and Wildlife Program (the Program) with specific recommendations. We suggest that, with better information, economics could be applied to achieve more at less cost. Economic considerations can help the region make the best use of limited resources while better protecting hydropower, water, fish, and wildlife assets.

Our recommendations are generally related to our charge to foster a cost-effective Program. Most recommendations are related to standardized achievement metrics, comparison of alternatives, and improved forecasting.

Economics requires forecasts of physical achievement metrics such as numbers or survival rates of fish or wildlife, or amount of power generation, flow, or habitat acreage. Several of our recommendations encourage better, standardized achievement metrics so that comparisons can be accomplished among more projects. Also, cost-effectiveness generally requires a comparison of common achievement metrics across alternatives. Sometimes, best plans are not selected because the best alternatives are not considered. Some of our recommendations encourage better project evaluation through consideration of a broader range of alternatives. Good planning requires, for each alternative, accurate forecasting of future conditions. We are concerned about how climate change and unforeseen costs could affect the efficiency of spending now and in the future.

We have provided fourteen recommendations below. Following each recommendation we provide a short explanation and description of the level of effort that might be required. We are unsure if the potential costs of these efforts would be money well spent. For now, we hope to encourage a dialog among stakeholders, scientists and planners regarding how to proceed.

Metrics and alternatives

Recommendation 1: Consider funding a science initiative to assess the state of achievement metrics, methods to standardize metrics, the value of comparing metrics across types of projects, and research needs to develop standard metrics.

Cost-effective spending for fish and wildlife restoration can increase the amount and value of restoration accomplished. Competition for Program funds is increasing. New initiatives involving more regions (Columbia River estuary and Willamette basin, for example) and research on toxic contaminants are being proposed, and native and non-native species that received little attention in the past now request and receive more funding. Anticipated

maintenance and replacement costs for existing projects may be increasing. At the same time, hydrosystem revenues may decrease as a result of new initiatives suggested by recovery plans and proposed spill experiments. Climate change could also have significant effects on the amount, timing and value of hydropower generation.

In the past, many funded restoration actions had uncertain achievements - the amount of restoration accomplished in terms of numbers of fish or wildlife, or acres of habitat, for example. Going forward, there should be less uncertainty about what physical metrics are appropriate and the expected amount of achievement. Council should expect proposals to have high quality of information about expected achievement. For some project types, achievement metrics should be improved and standardized.

Cost-effectiveness analysis requires comparisons of actions that have similar achievement metrics so that the cost per unit outcome can be compared directly. At this time, comparisons of cost effectiveness across actions are often impossible because the metrics of physical outcomes are different. Where projects target the same populations of fish or wildlife, the same achievement metric should be compared. There is potential for more standardization of metrics that would enable comparisons across projects. We recommend development of standardized achievement metrics for estuary, predator management, water transactions and non-native fish projects.

The level of effort for this recommendation, primarily by scientists, could be significant. However, if metrics could be standardized across most project types, the potential for practical cost-effectiveness analysis and better project design and selection would be substantially improved.

Recommendation 2: Where project proposals have important cost implications, and especially where investments are not reversible, ensure that staff, the science boards, and project proponents explore a full range of alternatives before decisions such as funding recommendations are made.

Cost-effectiveness analysis, and good planning and acquisition generally, require comparison of alternatives. Alternatives involve the full range of what might be done to advance objectives and in some cases should include the do-nothing alternative. It is reasonable to seek full understanding about the potential range of alternatives, to expect project proponents to explore alternatives, and to have proponents and others explain what alternatives have been considered and what their relative merits and costs might be.

This recommendation could require significant effort by project proponents and Council staff. However, the potential for practical cost-effectiveness analysis and better project design and selection would be substantially improved.

Non-native species and invasive species

Recommendation 3: Apply existing and new scientific research to identify situations (species, size, times, and places) where increased removal of non-native fish would be most effective in increasing native fish populations.

The importance of non-native species for the native species of the basin has recently become more appreciated. The ISAB (2008) produced a report on non-native fish that found "the potential impacts and risks to native salmonids and other native fishes from non-native species are significant, with most subbasins in the Columbia River Basin already dominated by non-native fish species (p. iii)." They note that the existing hydrosystem often provides habitat conditions that are conducive to these species. Sanderson et al (2009) found that the effects of non-native fish on natives may be large, yet the investment in studies and management is negligible by comparison. Sanderson provides these summaries of other studies:

- Smallmouth bass consume 35% or more of juvenile salmon outmigrants in some regions (p. 250)
- Juvenile shad prey heavily on zoo-plankton, which are also a primary prey resource for juvenile Chinook salmon (p. 249)
- Walleye consume an estimated 250,000 to 2,000,000 smolts annually in the Columbia River (p. 250)
- Predation by nonnative fishes on outmigrating smolts is roughly equivalent to the productivity declines attributed to habitat loss and degradation (p. 253)

Sanderson finds that, "of the $385 million distributed by BPA over the three-year (2007 to 2009) study period, only approximately 0.3% was directed in whole or in part toward research on the impacts of non-indigenous species (NIS), and slightly less than 1% of funds were allocated to efforts to control nonindigenous fish species (p. 254). The IEAB agrees with Sanderson that "the level of attention given to NIS seems disproportionately small, given the magnitude of the potential threat that NIS pose to native communities" (Sanderson et al, 2009, p. 254).

Smallmouth and largemouth bass, walleye, catfish, crappie, perch, shad and brook trout, all non-native species, are known to feed on or compete with juvenile salmonids. A few striped bass have recently been caught in the lower Columbia; it is unclear whether this important introduced predator could become significant in numbers.[1]

There are many complicated interactions between native and non-native species. The ISAB (2008) listed these types of interactions;

- Predation

[1] http://www.critfc.org/striped-bass-in-the-columbia-river/

- Competition for food and habitat
- Food web alterations
- Interbreeding
- Disease transmission and parasites

Management of non-native fish for sport fishing enhancement could lead to more risks for native fish. However, management is complicated by complex food web interactions. For example, bass and walleye are known to eat juvenile pikeminnow, an important predator of salmonids. Shad are important in the diets of pikeminnow and bass (Petersen et al 2014). Without a better understanding of such interactions it may be hard to document survival improvements and obtain cooperation from non-native sport fishers.

Non-native fish management should recognize that non-native fish can have different effects on native fish depending on food web interactions, time of year, and location and size of the non-natives. Biological information regarding non-native fish locations, densities and diets might be improved to support any proposed actions. In particular, when and where do large numbers of non-native fish feed heavily on the most valued salmonids?

This recommendation could require significant effort. The first step would be to exhaust existing studies and data and determine what additional studies would be required. Additional work would probably involve non-native fish diet sampling for different species, sizes, times and places. Also, radio tagging or similar technology might be applied to determine travel patterns of non-native fish released into new locations. Cooperation from recreational fishermen would help reduce costs.

Recommendation 4: Consider the opportunity to identify more creative management actions for non-native sport fish, including full consideration of angler behavior, to increase survival of desired native species.

Once the species, size, time, and place for effective non-native fish removals are established, detailed management strategies for these fish can be developed. There may be outstanding opportunities for cost-effective management of non-native fishes to benefit native fish. In particular, non-native sport fish that feed on native fish are already being caught and the additional cost to manage these fish may be low. In addition, non-natives are already being relocated within the basin to enhance fishing opportunities.

Management of non-native sport fish is complicated by the real economic value of these sport activities. Some sport fishing interests and State fish and wildlife agencies are reluctant to take actions that might reduce populations of popular sport fish. B.A.S.S. members in Washington,

Oregon and Idaho total 11,250 anglers.[2] The Columbia River was recently ranked 21st of 100 best bass fishing lakes in America.[3]

The ISAB (2008) recommended:

> that the Council urge the state agencies to relax (or eliminate) fishing regulations that may be enhancing populations of non-native species (both predators and competitors), especially those that directly or indirectly interact with juvenile and adult salmonids (p. iv).

Washington considered two options for changes to 2013-14 regulations to reduce negative interactions between Endangered Species Act (ESA) listed anadromous fish and predatory warm water fish. Staff recommended two options that would modify or remove size and daily limits for bass, walleye and channel catfish in the Columbia River, Snake River and their tributaries.

Following a public comment period in which 248 comments and 11 letters were received, the Commission adopted Option 1, "Remove size and daily limits for bass and walleye and daily limits for channel catfish in the Columbia River, Snake River and their tributaries." The Oregon Department of Fish and Wildlife has also proposed "to remove protective creel and size limits from all non-native species, including black bass."[4]

However, according to a spokesperson for B.A.S.S., "bass anglers by and large are catch-and-release anglers, so removing size and bag limits will have almost no effect on take of bass."[5]

Perhaps the removal of creel and size limits will not have a significant effect on non-native fish predation. More informed management alternatives should consider angler preferences and behavior, effort, catch, and release patterns, as well as potential for native fish survival improvement.

There are many other complex interactions with angler behavior. For example, recreational anglers easily confuse brook trout with bull trout, so regulations to allow more take of the non-native brook trout could result in more bull trout take by accident. Management alternatives need to be thoroughly vetted.

Non-native fish are probably important survival factors for native fish in some situations, little has been done to manage non-native sport fishing, the fish are often being caught and released, and some fishing boats have live wells that allow fish to be held unharmed for the day.

Creative management might include:

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[2] http://www.bassmaster.com/news/bass-vs-salmon-can-they-not-coexist?page=2
[3] http://www.bassmaster.com/news/100-best-bass-lakes-2013
[4] http://www.bassmaster.com/news/bass-vs-salmon-can-they-not-coexist
[5] http://www.bassmaster.com/news/bass-vs-salmon-can-they-not-coexist

- Removal of non-natives by netting, electroshock, or other, non-sport fishing methods
- A requirement that non-native fish caught in specific circumstances could not be released into that location
- Special size limits or windows within which non-native fish could not be released
- Bounties or rewards for fish in situations known to be especially damaging.

Bass are commonly moved around water bodies in the region; for example,

> The Central Oregon Bass Club participated in an electroshock and fish transfer from Davis Lake to other multiple lakes throughout the state in 2011. Conducted by the Oregon Department of Fish and Wildlife biologists, this is the fifth annual survey that the COBC has taken part in. On multiple nights, the waters were electroshocked, allowing the volunteers to collect 1,500 fish in net pens. On the last day the fish were divided into shares for each lake.[6]

Fish were transplanted to Prineville Reservoir, Lost Creek Reservoir, Willow Creek Reservoir, McKay Reservoir, and some smaller ponds.

As far as we know, there are no recent, detailed studies that would answer most of the necessary questions regarding angler behavior including effort, catch, by-catch and release patterns. First, existing data and studies regarding fishing location, effort, catch and release patterns should be exhausted. There are compiled databases of literature.[7] Then, additional survey data regarding angler behaviors and preferences might be advised.

Recommendation 5: Develop native fish survival metrics for non-native sport fish management that are comparable to existing hydrosystem survival metrics.

The primary purpose of non-native sport fish management is sport fishing opportunities, but management could be changed to enhance native fish survival. Metrics of improvement should be similar to those required and provided for hydrosystem actions. Cost-effectiveness could be gaged by comparison to hydrosystem or habitat costs. A method and metrics for comparison of survival improvements from non-native sport fish management to hydrosystem actions would facilitate cost-effectiveness comparisons.

This recommendation could be implemented as part of Recommendations 3 and 4 at little additional cost.

[6] http://www.bassmaster.com/news/oregon-anglers-transfer-bass-throughout-state

[7] http://recvaluation.forestry.oregonstate.edu/

Climate change

The potential for climate change to affect fish and wildlife is becoming more widely appreciated. The ISAB produced a report detailing potential effects of climate change on fish and wildlife (ISAB 2007). At the time, these types of effects were foreseen:

- Warmer temperatures will result in more precipitation falling as rain rather than snow
- Snow pack will diminish, and streamflow timing will be altered
- Peak river flows will likely increase
- Water temperatures will continue to rise (p. iii)

Other effects that have been foreseen include ocean acidification, habitat fragmentation, increase in intensity and area burned by wildfire, and increased evaporation rates on land and water surfaces.

Recommendation 6: Take a leadership role in developing standard baseline assumptions for a future with climate change. Incorporate assumptions into planning tools, and suggest that project proposals should utilize these assumptions where appropriate.

While climate change can have profound effects on the fish and wildlife resources in the Columbia Basin, their consideration in planning efforts is often uneven. There are efforts underway that seek to define the expected influence of climate change in the region. Our recommendation supports these efforts. Additional effort, primarily by Council staff, would not be large.

The Council has a leadership role in the analysis of regional power generation, and this role should be continued and even expanded so that the Council continues to be a national leader in problem-solving for regional power planning with climate change. Complicated interactions between climate change and power demands, the hydrosystem, renewables and traditional generation mean that complicated models are required to show how changes in climate and hydrosystem generation affect power markets, capacity requirements, carbon emissions, and fish survival.

Hydrologic and hydrosystem models often rely on historic hydrology. While historic hydrology does provide a good basis of understanding, it can no longer be assumed to be representative of future conditions. Specific, quantitative assumptions for revised future development conditions (for example, 2050) are advised.

We believe that the Council is already working in this direction. Additional effort, primarily by Council staff, would not be large.

Recommendation 7: Stay abreast of climate change science and forecasts, and evaluate fish and wildlife investments for their ability to perform in a wide range of potential future climate conditions.

While climate change has become increasingly certain, the consequences of climate change for the Basin are still highly uncertain. Increased uncertainty in future climate means that fish and wildlife projects should be robust with respect to climate change uncertainty. Projects should perform well in a range of conditions, but in particular, in conditions outside the range of historical experience. The science of climate change, and the outlook for regional climate conditions, are both changing quickly, and the Council should take steps to ensure that the Program stays updated with respect to the most recent science.

We believe that the Council is already working in this direction. Additional effort, primarily by Council staff, would not be large.

The future may include unprecedented events caused by climate change. In particular, high temperature summer events following dry years could challenge the reliability of the power system. Contingency planning, including expected protocols, is advised. Such plans could include policies to enable exceptional fish survival tools and water marketing in drought emergency conditions.

This recommendation could be considered within a larger effort to develop emergency contingency protocols as described in Recommendation 14.

Recommendation 8: Ask the ISAB, Ocean Forum, or similar group to prepare a short issue paper regarding ocean acidification to clarify how important ocean acidification might be for Council interests.

Increases in atmospheric carbon dioxide have increased ocean carbon dioxide leading to increased acidity (lower pH) and reducing the availability of minerals in oceans around the world.[8] Many species use the naturally occurring carbonate minerals calcite and aragonite for calcification. It is unclear how ocean acidification might affect Pacific Northwest salmon, steelhead trout and other anadromous species through food web effects. New research on this topic may be underway.[9] To our knowledge, there is no statement regarding the potential interaction of ocean acidification and Council interests.

This recommendation is already being implemented, so additional effort should not be large. The issue paper should address the timing of acidification effects and provide a discussion that clarifies uncertainty about food web and potential selection effects (could the directly affected species evolve to become tolerant of more acidic oceans?).

[8] http://www.epa.gov/climatechange/science/indicators/oceans/acidity.html
[9] http://climatesolutions.org/news/alaska-researchers-to-study-effects-of-ocean-acidification

Predation

Columbia River salmon and steelhead, waiting to move up the fish ladders at Bonneville Dam, are consumed by California sea lions. Since 2002, sea lions have consumed thousands of migrating fish annually, many from ESA listed runs. As much as 4 percent of adult spring Chinook salmon population may be consumed at Bonneville.[10] The Corps and BPA take these actions to reduce predation by sea lions:

- install sea lion exclusion devices (SLEDs) at all main adult fish ladder entrances at Bonneville Dam on an annual basis.
- support land and water-based harassment efforts to keep sea lions away from the area immediately downstream of Bonneville Dam.
- support efforts to monitor sea lion abundance, distribution, predation rates and the effectiveness of deterrent actions.[11]

The federal Marine Mammal Protection Act recognizes that predation by a growing sea lion population can jeopardize salmon and steelhead. Wildlife managers from Washington and Oregon have worked with federal and tribal partners to haze sea lions since about 2007. In March 2008, state fish and wildlife agencies in Washington, Oregon and Idaho received federal authorization to remove problem sea lions using lethal metrics. The states' first priority has been to relocate them to zoos and aquariums where practical. Through 2012, wildlife managers removed a total of 54 California sea lions – 11 of which were sent to zoos and aquaria. In 2013, the state agencies will mark their ninth year in this effort.[12]

The number of salmon consumed by sea lions below the dam has declined in the past two years, but predation rates are still in the thousands and it is too early to assess the long-term effectiveness of management efforts. Metrics of reduced mortality from increased predator management, and costs, should be compared to adult equivalent mortality and costs from other adult fish projects to see if additional management might be warranted. The effort and cost required to develop improved metrics for predator management may not be large.

Estuary

The Council received many recommendations that would expand the Council's role in protecting and restoring estuarine habitat.

[10] http://www.ppcpdx.org/documents/Mythbusters6one-pager.pdf
[11] http://efw.bpa.gov/IntegratedFWP/anadfishpredation.aspx
[12] http://www.dfw.state.or.us/fish/SeaLion/index.asp

Recommendation 9: Until the science is improved, require a high level of evidence, or reversibility (for example, lease land or buy lease options instead of fee purchase), before funding specific estuary projects aimed at salmonid survival.

Some comments and recommendations received so far suggest an estuary plan, or development of detailed strategies. The cost-effectiveness of many possible estuarine actions should be considered. However, at this time it appears that there is little research that can demonstrate increased salmonid survival from estuarine actions with high certainty.

Currently, the Corps of Engineers and Bonneville Power Administration are responsible for the Columbia Estuary Ecosystem Restoration Program (CEERP). Three documents from this program were reviewed by the ISAB (ISAB 2012). While "the three draft documents provide an effective overview of the current status of the CEERP" the ISAB finds "additional evaluation is needed to determine if inferences generated in the Synthesis (Section 6) allow the conclusion that restoration is working to help recover salmon (p. 1)." Also, "The Synthesis identified the very serious shortfall in action effectiveness monitoring for the estuary restoration projects (p. 1)." In addition, "there is no discussion in the Synthesis memorandum about how survival benefit units (SBU) are estimated by the ERTG (Expert Regional Technical Group) and will be used to estimate the potential effectiveness of habitat restoration work (p. 5)." Finally, "the most critical gap identified is to determine the relative contribution of salmon life histories in the estuary to returning adults" (p. 8).

All of these statements suggest that better science is needed to support potential actions in the estuary. In 2014, the ISAB evaluated ETRG documents and found "the ability of projects to actually succeed in increasing the survival of salmon through their residence and migration in the Columbia River estuary cannot be determined from the Scoring Criteria" (ISAB 2014 p. 2).

Therefore, if the Program is to become involved in funding projects in the estuary, better scientific information is suggested before specific actions or projects should be funded, and investments should be reversible in case the future science does not support actual survival improvements. Reversibility might be achieved through land lease instead of purchase. Also, lease options could be purchased whereby the Program would pay to exercise its option only when conditions are most conducive survival improvements.

This recommendation should not require much additional effort or cost as compared to current plans.

Water transactions

The IEAB reported on irrigation efficiency and water transactions in 2011 (IEAB 2011). We found that

> both irrigation efficiency projects and water transaction projects have been used successfully to achieve an increase in instream flow at times and in locations where the fish habitat is impaired (p. 4).

We agree with other commenters that better metrics of resulting fish survival are needed, especially as the water transactions program may be expanded incrementally into places and times where benefits are not as certain. Common metrics on fish survival are needed so that the effectiveness and cost-effectiveness of water transactions can be evaluated and compared to hydrosystem actions and other fish habitat projects.

Recommendation 10: Help CBWTP investigate where expanded conjunctive use might help meet instream flow requirements.

One general water acquisition strategy that deserves more attention in the region is expanded conjunctive use of surface and groundwater. Conjunctive use occurs when a water user, typically an irrigator, is able to use either surface or groundwater. For fish, groundwater would be used instead of stream water in dry years thereby leaving more water instream for fish.

There are two potential strategies to increase flows when needed for fish.

1. For stream-irrigated land that is currently not served by groundwater, develop groundwater pumping capacity. Pump more groundwater and divert less stream water in dry years.

2. For land currently served by groundwater and stream water, pump more groundwater and divert less stream water in dry years.

Additional groundwater pumping can have adverse effects on water users and environmental resources. In some cases, the groundwater might be recharged naturally so that future groundwater cost and availability are largely unaffected by pumping groundwater to exchange for stream diversions. In other cases, artificial recharge may be appropriate. To mitigate, new groundwater recharge capacity could be developed to recharge the groundwater when excess surface water is available.

In some cases, recharge might be accomplished by in-lieu recharge: surface water is provided in-lieu of groundwater so recharge is accomplished simply by leaving water in the aquifer. In lieu recharge has an economic benefit compared to other recharge methods because future pumping costs for the recharged water are completely avoided.

The effort and cost required to implement this recommendation, primarily local studies involving conjunctive use potential, might be small. Costs of new groundwater pumping and recharge facilities might be significant.

Willamette River actions

Recommendation 11: Take initiative to understand how changes to the Willamette system mandated by the Bi-op will affect the Fish and Wildlife Program and the FCRPS.

Under the ESA, NMFS was required to issue a biological opinion on the operation of the Corps' Willamette Project facilities, including 13 dams and reservoirs, 42 miles of bank protection projects, and a hatchery mitigation program.

The 2008 Biological Opinion identified the following major actions that will significantly help recover listed salmon and steelhead in the Willamette Basin:

- Reduce the impacts of altered water temperatures in the North Santiam by actively managing water releases from Detroit Dam and reservoir to benefit listed fish survival in 2009 and beyond;
- Achieve long-term temperature improvements at Detroit Dam through operational changes or structural modifications by 2018;
- Construct and operate downstream passage facilities to safely pass emigrating listed fish at Cougar Dam by 2014, at Lookout Point Dam by 2021 and at Detroit Dam by 2023; Reconstruct and operate adult fish collection facilities at various Willamette Project dams to facilitate safe collection and transport of listed fish for outplanting above the dams and for hatchery broodstock purposes;[13]

The Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead was prepared by Oregon Department of Fish and Wildlife (ODFW) and the National Marine Fisheries Service (NMFS) Northwest Region in 2011 (ODFW and NMFS, 2011). Recovery plans are supposed to provide cost information, however, little cost information was provided in this plan. One exception is (CRE-3), establishing minimum instream flows for the lower Columbia River mainstem to help prevent further degradation of the ecosystem, is estimated to cost $44.5 million (p. 9-43). It is unclear whether this is a one-time or annual cost.

Cougar dam, which blocks the south fork McKenzie River, is 518 feet tall. Proposed actions would restore adult access of natural origin fish to historic habitat and provide safe and effective downstream passage through the dam (p. 9-140, p. 9-142). Interim trap-and- haul measures would be used to outplant adult fish into historical habitat above the USACE Cougar flood control/hydropower complex. (p. 9-153)

Detroit dam, which blocks the North Santiam River, is 463 feet tall. Safe and effective downstream passage through Detroit reservoir and Detroit and Big Cliff dams would be studied and developed for juveniles and kelts, by 2023 or sooner. Until then, natural achievement would

[13] http://www.dfw.state.or.us/fish/CRP/docs/upper_willamette/FAQ.pdf

be supplanted by implementing interim trap-and-haul metrics to outplant adult fish into historical habitat. Also at Detroit dam, a temperature control structure would be constructed to improve water temperatures to benefit Chinook and steelhead

Lookout Point dam blocks the Middle Fork Willamette River. Similar management changes and improvements are proposed.

Uncounted costs in the recovery plan include costs of upstream and downstream migration facilities and their operations. In addition, hydropower generation or value will be reduced by requirements for lower water temperatures, faster migration times, and juvenile bypass. Migration times through reservoirs are reduced by reservoir drawdown, and migration downstream of reservoirs is accelerated by increased flows. Bypass flow, flow that does not generate power, will be required for juvenile bypass systems. While structural costs may be paid through the Army Corps of Engineers, reduced hydropower generation will affect regional power consumers.

Since the recovery plan does not document costs of most proposed actions, an effort to document potential costs of recovery is needed. It is not clear from the description of recovery actions how much of the actions are currently being provided, and what additional costs may be required. BPA is planning to spend between $500,000 and $800,000 per year for Willamette Basin habitat improvements targeting endangered fish.[14] The recovery plan discusses many other factors that limit populations including non-native fish. Research on cost-effectiveness of actions to address these other limiting factors might help channel limited funds.

Effort and costs required to implement this recommendation could be significant. NMFS is required by the ESA to provide costs in their recovery plans; perhaps they should accept some of the responsibility and cost required to develop better cost information.

Maintenance of program investments

The Council received numerous recommendations regarding maintenance of investment. Importance maintenance costs involve protection and restoration of wildlife habitat, including ongoing management for invasive plant and animal species, maintenance and replacement of fish screens and fishways, and maintenance and upgrades at hatcheries. The IEAB agrees that existing projects might not achieve their planned potential because they have not adequately planned for future costs that could be anticipated now.

Recommendation 12: Proposals for new projects that will require future operations, maintenance, replacement or decommissioning costs should provide a table of expected life cycle costs by year, including the expected life of depreciable assets, and a discussion on how future costs will be paid.

[14] https://www.salmonrecovery.gov/BiologicalOpinions/WillametteBiOp.aspx

Existing projects that may require unfunded costs for future maintenance or replacement should provide such cost information as soon as practical.

These types of real cost increases (cost increases above inflation) or unforeseen costs can be expected:

1. Operations costs may increase because energy costs are increasing in real terms. Other costs such as water transactions costs may also increase faster than inflation;
2. Maintenance costs generally increase with age;
3. Replacement costs may be required at regular intervals as components wear out. Often, replacement costs are related to maintenance costs in that increasing maintenance costs may make replacement economical;
4. Decommissioning costs may be required when an obsolete project needs to be removed, and
5. Natural disasters can result in substantial, unplanned costs. Natural disasters could involve floods, drought, fire, volcanic eruptions, earthquakes, or invasive species.

Regarding 3), the IEAB has suggested that the expected life of depreciable assets be included in standard project reporting so that expected annualized costs can be calculated (IEAB 2006). We wrote:

> More information about the expected life of improvements and the duration of benefits would be useful for basic economic analysis. The share of cost that is a long-term investment, the expected life of these investments, and the expected timing of benefits in the future, should be provided if available (IEAB 2006-2 summary).

Information about the expected life of improvements would also help identify when replacement costs might be required. Also, a requirement for reporting of expected life would help foster comparisons between different options for investments in items like screens and fencing.

Regarding 5), a separate Recommendation 14 is provided.

Recommendation 13: Consider the advisability of an external review of the future financial needs, the ability to meet those needs, and alternatives for financing those needs, for the entire Fish and Wildlife Program, that considers long-term needs identified in Recommendation 12, as well as the expected hydrosystem revenue base.

Effort and costs required to implement this recommendation could be significant. Information from Recommendation 12 would provide some of the cost information needed to forecast total future costs.

Disaster Management

Recommendation 14: Develop information regarding how large, sudden, and unexpected damages to human, natural and infrastructure assets within the Council's responsibilities might be corrected or mitigated in a timely manner.

Natural disasters will happen and the location and type of damages cannot be foreseen. However, it may be the case that an ability to take corrective action quickly will reduce the costs and damages to fish and wildlife resources and other assets. Having a plan and streamlined processes in place, and a funding mechanism that can respond quickly, could both help to reduce the amount of damage and its cost. The compiled information might include existing emergency management programs, protocols, locations and amounts of assets (construction equipment, experts) that might be employed, and existing permitting and funding constraints. The information development might be informed by case histories such as the Mt. Saint Helens disaster, the 2014 Wanapum Dam case, and planning efforts such as the 100th Meridian process, for example. With better information, proposals for new expediting protocols might be appropriate, and risk-reducing investments might be considered

With climate change, the chance for unprecedented dry years and hot summer conditions now seems more likely. The disaster management plan might consider how existing plans and protocols might perform in unprecedented dry years and hot summer weather. The relevant plans might include juvenile transportation, juvenile bypass spill, water acquisition, and hatchery management.

Effort and costs required to implement this recommendation could be significant.

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