A Joint Independent Scientific Review Panel and Independent Economic Analysis Board Review for the Northwest Power and Conservation Council

SAFE Review 2007

Review of the Select Area Fishery Evaluation Project Reports:
Final Completion Report, October 1993 to October 2005 (April 2006)
and Economic Analysis Study (November 2006)
Project #1993-060-00

April 11, 2007
ISRP & IEAB 2007-3

Independent Scientific Review Panel

Richard Alldredge
Peter Bisson
John Epifanio
Linda Hardesty
Charles Henny
Colin Levings
William Liss
Eric Loudenslager
Katherine Myers
Thomas Poe
Bruce Ward
isrp@nwpcc.org

IEAB Independent Economic Analysis Board

Noelwah R. Netusil, Chair
Kenneth L. Casavant
Susan S. Hanna
Daniel D. Huppert
Joel R. Hamilton
Roger Mann
Lon L. Peters
Hans Radtke[1]

ISRP and IEAB 2007 Review of the SAFE Project Reports

Contents

[1] Dr. Hans Radtke, IEAB member, was an author of the economic analysis reviewed by the IEAB. Accordingly, Dr. Radtke was recused from the IEAB review.

Executive Summary

The ISRP and IEAB reviewed two reports pertaining to the Select Area Fisheries Enhancement Project (SAFE). The ISRP evaluation focuses on "Select Area Fishery Evaluation Project, October 1993 to October 2005" (April 2006). The IEAB evaluation focuses on the economic analysis "Select Area Fishery Evaluation Project, Economic Analysis Study, Final Report" (November 2006).

ISRP

In general, the ISRP found that the SAFE project appears successful, providing high and relatively stable harvest rates with minimal impacts on non-target and listed stocks, especially those above Bonneville Dam. The project is consistent with the Northwest Power and Conservation Council's Fish and Wildlife Program and the Bi-State Lower Columbia River and Columbia River Estuary Subbasin Plan. Survival rates of SAFE fish are generally about equal to or better than those achieved at lower Columbia River hatcheries. Harvest of SAFE fish makes up a significant component of the lower Columbia River catch of salmon. Adaptive management has been a key component of the project. The fishery has been carefully monitored to assess catch and effects on non-target stocks and regulations have been adjusted when deleterious impacts have been observed or anticipated.

However, some concerns about the project and report remain. Discussion of methods in the report could have been more comprehensive and complete, and statistical analysis of the coded wire tag and experimental study data was entirely lacking. The report does not present convincing evidence that there is opportunity for expansion of production, and they do not explain why the maximum production goal of 11,300,000 smolts was chosen. Methods for estimation of harvest rates and "impact rate" of select area fisheries on non-target and listed stocks should be discussed more clearly. Because the estimate of harvested fish is not verified, concerns are raised about the validity of the income generated from the fishery. A critical unknown of the SAFE program is potential impacts of large releases of SAFE fish in the future on other populations during periods of prolonged poor ocean conditions.

Consequently, the ISRP recommends:

- Extreme caution should be taken in expanding production in future years. Ultimately, continuous monitoring is essential to determine harvest and survival rates, impacts on non-target fish stocks, and stray rates of SAFE fish as production increases. The assumption should not be made that because impacts appear nominal with the present scale of production, they will continue to be so as the fishery expands.
- The actual number of smolts released from the net pens should be determined.
- Coho stray rates should be estimated.
- A competent statistician should be involved in project design and analysis of data.
- Marking fish using thermal otolith marking techniques should be considered.
- The SAFE project can contribute to furthering understanding of effects of ocean conditions on salmon.

Full rationale supporting the ISRP's recommendations is provided in the main body of the report.

IEAB

The economic analysis is generally responsive to the economic issues raised in the 2005 ISRP/IEAB review, although the report presents some problems with regard to documentation, detail, and clarity of analysis that make it difficult to review.

The two general questions addressed by the economic analysis are whether changes to the SAFE project would generate net economic benefits and whether the SAFE project is a cost-effective approach to a mitigation fishery in the lower Columbia River.

Does the SAFE project generate economic benefits?

- The SAFE project generates economic benefits by providing relatively inexpensive fish for harvest, but the analysis does not provide all the information needed to determine if the SAFE investment provides a net economic benefit.
- Total project costs appear to exceed benefits with or without BPA funding, resulting in a negative net economic value (NEV) for the project overall.
- The Economic Study estimates that a loss of BPA funding would cause a net economic loss by reducing SAFE project NEV to levels below current levels.
- The estimate of economic impacts is based on assumed constant SARs, but SARS vary from year to year. Therefore, actual annual project benefits could be less than or greater than those reported.
- The net benefit of expanding SAFE project recreational and commercial fisheries beyond present levels is not estimated.
- An additional benefit of the SAFE project is the positive demonstration effect that terminal fisheries can provide harvest opportunities with minimum impact on protected stocks.

Is the SAFE project a cost-effective approach to a mitigation fishery? The cost-effectiveness of the SAFE project can be judged relative to the cost of other means to accomplish the same or sufficiently similar ends.

- The SAFE project allows for more harvest than would the release of equivalent numbers of smolts from upriver hatcheries.
- The increase in catch through the SAFE project could be achieved through expansion of upriver hatchery releases, but that would cost more per fish caught and would increase the risk of incidental catch of ESA protected species.
- The assessment of SAFE project cost-effectiveness is impeded by the current absence of alternative means to enhance catch without increasing risk to ESA protected stocks.
- The impacts of SAFE on catch of ESA stocks are not quantified. Consequently the analysis could not provide a complete cost-effectiveness analysis.
- It seems likely that the cost-effectiveness analysis, comparing the costs of alternative means of achieving SAFE project objectives, would be likely to favor the current SAFE approach to catch enhancement.
- The question of the cost-effective level for the SAFE mitigation fishery is not assessed.

Background

As part of the Fish and Wildlife Project Funding Recommendations for Fiscal Years 2007 through 2009, the Northwest Power and Conservation Council conditioned funding for Project 199306000: Select Area Fisheries Enhancement Project (SAFE) on the "sponsors completing their submission of information to the ISRP and IEAB to address the biological and economic issues raised in the ISRP/IEAB joint review (ISRP and IEAB Document 2005-8)."

The ISRP/IEAB review, provided below, marks what should be a final step in a multi-year iterative review of the SAFE project that included proposal reviews in the Rolling Province Review Process and recently in the FY 2007-09 project review process, as well as a joint ISRP/IEAB review of a SAFE 10-year report.

In 1993, the Bonneville Power Administration initiated the Columbia River Terminal Fisheries Project (now named the Select Area Fishery Evaluation (SAFE) project), a 10-year comprehensive program to investigate the feasibility of terminal fisheries in Youngs Bay and other sites in Oregon and Washington. This cooperative project between the Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), and Clatsop County Economic Development Council's (CEDC) Fisheries Project explored the means to increase harvest of hatchery fish while providing greater protection to weak wild salmon stocks. In 2005, at the request of the Council, the ISRP and IEAB reviewed the "Select Area Fishery Evaluation Project, 1993-2003 Final Project Completion Report" (Completion Report). The Completion Report was submitted to address conditions placed on the project as part of the Council's Lower Columbia River and Estuary provincial review decision. Key points from the 2005 ISRP/IEAB review are listed below.

The goal of the SAFE project is “to determine the feasibility of creating and expanding known stock sport and commercial fisheries in the Columbia River Basin to allow harvest of strong anadromous salmonid stocks while providing protection to depressed stocks.” The SAFE project cultures and releases into the estuary coho, spring Chinook, and select area bright (SAB) fall Chinook salmon for harvest in the ocean, lower Columbia River, and select area fishing zones, by commercial and recreational fisheries. The in-river fisheries are commonly referred to as terminal fisheries. The SAFE assesses biological attributes of the fisheries that include success of rearing juvenile salmon in select area hatcheries and net pens, the survival and catch of these fish as returning adults, stock composition of the catch with particular emphasis on incidental catch of fish from listed stocks, the impact of the incidental catch on non-target and listed stocks, and straying of fish reared for the select area fishery into spawning areas where they could pose a conservation risk through interbreeding with listed stocks.

The 2005 ISRP/IEAB review identified a number of biological and economic issues and concerns in the "Select Area Fishery Evaluation Project, 1993-2003 Final Project Completion Report" that needed attention and improvement. This review presents the ISRP and IEAB evaluation of the SAFE project response to the 2005 review in two major sections. Section I provides the ISRP review of the final project report “Select Area Fishery Evaluation Project,

October 1993 to October 2005." Section II provides the IEAB review of the economic analysis "Select Area Fishery Evaluation Project, Economic Analysis Study, Final Report."

I. ISRP Review of "Select Area Fishery Evaluation Project, October 1993 to October 2005"

The ISRP/IEAB 2005 comments on the "Select Area Fishery Evaluation Project, 1993 – 2003 Final Project Completion Report" are listed below in bold type, followed by the ISRP evaluation of the response provided by the project in the report "Select Area Fishery Evaluation Project, October 1993 to October 2005."

1. The report does not adequately describe or reference either the biological or economic methodology used in the project. This is a major concern. Without methods of sampling and analysis described and documented, it is not possible to verify reported results and ensure that repeatable procedures can be applied in the future.

ISRP Evaluation
The sponsors clearly made an effort to improve discussion of methods over earlier reports; however, the report only partially explains the basis for estimates of many of the biological parameters, methods for some important analyses were not given, and statistical analysis is generally absent. It should be noted that the "methods" requested in the ISRP/IEAB's original review pertained primarily to monitoring and evaluation (i.e., analytical) rather than methods or practices for culture and release (it is necessary, however, to describe fish culture practices in the report).

The following are the ISRP concerns about the methods. A detailed discussion of these concerns is given later in this review.

- There is an absence of quantitatively derived estimates of the actual number of smolts released from the facilities.
- The stock composition and biomass of the harvest cannot be established based on the data provided.
- The methods for forecasting runs (page 36) are described, but no actual data or examples are provided, and there is no citation as to where the data can be found.
- The report needs to describe explicitly the stock characteristics that were used to distinguish SAFE, lower river, and upriver stocks using VSI.
- In general, methods used to estimate ocean catches of SAFE salmon and to identify non-SAFE salmon stocks are not adequately described, and statistical methods are inadequate (e.g., no estimates of variance for point estimates).
- Methods to determine the catch in the Select Area Fisheries were not specific enough, and no data was actually presented to validate the estimates.
- There should be better justification and addressing of assumptions for using coded wire tags rather than other marking methods.
- Rigorous statistical analysis of the data is missing.

- There are difficulties with application of Smolt-to-Adult (SAR) rates to the SAFE fishery due, in part, to variation in ocean conditions and harvest regimes.

2. Production goals are unclear. What is meant by "full implementation" is not specified. The question of the cost-effectiveness of further expansion is not addressed.

ISRP Evaluation
Full implementation apparently means meeting the long-term (> 10 years) smolt production goals given in Table 10.1. This goal is a substantial increase (approximately 2.3 fold) over current production (4,850, 000 vs. 11, 300,000 smolts). The project sponsors plan to increase production through a number of means such as improving smolt survival by employing various fish cultural methods, expanding rearing facilities, and adding additional smolt production sites at other locations in the lower Columbia.

While the report clearly recognizes that various kinds of constraints (given on pages 139 and 140) could hamper or even prevent the production goal from being achieved, it does not present convincing evidence that there is opportunity for expansion of production. Some of the hatcheries used for juvenile and smolt production already are limited by environmental conditions – particularly limited water supplies and high temperatures. There also have been losses to disease at the current production levels. Project sponsors propose that some of these problems can be solved through facility engineering or process improvement such as by using supplemental oxygen in the production facility. Ultimately, the information needed to evaluate the potential for expansions based on improved culture facilities are not clearly described.

In addition to the basic uncertainties regarding feasibility, no evidence is provided to support the rationale for expansion of the fishery in general and to the specific level outlined. The report does not explain why the maximum production goal of 11,300,000 smolts was chosen. Nor does it provide a goal for the number of returning adults expanded smolt production will produce, which would appear to be the actual goal of the expansion. In addition, the report does not present evidence that there will be economic demand for an increase in number of returning adults (i.e., how does increasing supply lead to an increased demand). Even if there were an "unlimited" production capability, there could be limits on recreational demand and profitability of the commercial enterprise as the supply of fish increased. The closure of one of the fisheries (Steamboat Slough) because of insufficient participation in the fishery illustrates the potential problem. Ultimately, all ecological risks and favorable costs-to-benefits being accounted for, the report needs to estimate as well as possible what level of demand and therefore harvest can be expected and under what economic conditions. This estimate should guide production levels (modulated by ocean survival) in the future. Ultimately, if too many fish are returned or if the harvest is otherwise inefficient, a significant number of adults may escape the fishery, for which the ecological costs to non-target species or stocks are not known.

Based upon the success achieved to date by the Selective Area Fishery, there is the assumption that expansion of and demand for this terminal fishery will continue to increase in the future. Any expansion of the fishery should be approached with great caution. The report does not thoroughly discuss what the anticipated impacts on non-target and listed species could be from significantly increased production, and how these impacts would be minimized. For example,

with the current level of production, little straying is evident, but straying (total number of strays) could increase if greater numbers of select area adults return to the lower river. How will such an event be dealt with if it occurs? Moreover, if over the next 10 years recovery of upriver stocks is successful and ocean conditions are favorable, more adult fish from these upriver stocks would migrate through the lower river and be taken incidentally in the select area fishery. How would this situation be handled? The project sponsors have successfully dealt with these issues to date, and the expectation is that they will do so in the future. For example, they have altered the fishing seasons or the SAFE fishery has been closed to minimize effects on non-target stocks. Nevertheless, articulating a risk management strategy is definitely warranted.

3. The reported 80-90% harvest rates of SAFE stocks are extremely high. The report should verify these rates and demonstrate that they are achievable without unwarranted impacts on local fishes.

ISRP Evaluation
The harvest rates seem reasonable, assuming that the numbers harvested and the stock composition are further verified. The project sponsors justify high harvest rates by arguing that harvest opportunities can be liberal because the select area fishery is terminal and the fishing areas are removed from the mainstem Columbia allowing intense harvest without affecting non-target stocks, which apparently do not use these areas extensively. The report provides evidence of very low impact to non-target and listed stocks.

Methods for estimation of harvest rates, however, need to be discussed more thoroughly to provide the means for a reviewer to consider assumptions and test computations. The report discusses an "impact rate" of select area fisheries on non-target and listed stocks, but they do not define "impact rate" and how was it determined? It also is not clear how the "percent of upriver stocks" was derived. Further, some of the numbers used to determine this percentage seem incorrect. For example, the stock percent for 1992 Youngs Bay is given as 0.024, but is reported as 2% in Table 3.7. Multiplication of the total harvest of upriver stocks given in Table 3.8 by 0.024 per cent yields 0.071 fish. Multiplication of the total harvest given in the table by 2.4% yields 7.1 fish, the number of upriver fish the report estimates were harvested. The values in the columns should be consistent, and it should be clear how they were estimated.

4. Fishery impacts on listed as well as non-listed stocks should be better evaluated and described.

ISRP Evaluation
The report presents empirical evidence, based on analyses using coded wire tag returns, that take of non-target and listed stocks in the select area fishery is relatively small, amounting in most instances to a few percent and, for upriver stocks, to less than one percent. Furthermore, with a few exceptions, stray rates of spring and SAB Chinook adults were generally low, especially above Bonneville Dam. It is not known what genetic impacts, if any, the low number of strays will have on naturally spawning fish. Stray rates for coho salmon were not reported. The project sponsors should have explained why estimation of coho straying was not undertaken.

When unacceptable impacts on non-target and listed species were anticipated or observed, the managers responded adaptively. In some cases, the fishery was shut down. When excessive straying was observed from a particular release location, the smolt rearing location was shifted to achieve more favorable stray rates. The production of a stock with an excessive stray rate (e.g., Upriver Bright chinook) was discontinued.

The report argues that the harvest of listed fish is within acceptable limits. This ultimately may be the case; however, the key question is whether harvest impacts are within the limits set up by the Biological Opinion that authorizes the fishery. The report needs a better discussion, especially in the future planning section, of the limits imposed on the select area fisheries within a season because of ESA mandated limits being reached in mainstem Columbia River fisheries, as occurred in 2003.

The potential impact of large releases of SAFE fish on other populations during periods of prolonged poor ocean conditions cannot be evaluated with any of the information provided in this report. Furthermore, if the SAFE project continues, there should be a strong emphasis on the use of SAFE salmon for scientific research and experiments to quantify and evaluate: (1) the effects of climate, ocean conditions, and ocean fishing on growth and survival of Columbia River salmon, and (2) trophic (density-dependent) interactions between hatchery and wild Columbia River salmon in the estuary and ocean. This work could be coordinated with ongoing ocean and estuarine research funded by BPA.

5. The rationale for importation of a non-target stock is not explained, but should be

ISRP Evaluation
The Select Area Bright (SAB) Chinook fishery was derived from the Rogue River stock. The reports provide a satisfactory explanation for selection of this stock for propagation in the select area fishery. They state that this stock was suitable for propagation because of its high survival rate, high quality flesh, and the southern migration of fish in the ocean after release, which could afford additional harvest opportunities. Straying was a major problem when the fishery was established, but was reduced significantly to acceptable levels by moving the location of the SAB propagation facility. Spring chinook and coho stocks reared for the select area fishery come from lower river hatchery stocks in Washington and Oregon. Production of Upriver Bright Chinook was discontinued due to excessive straying. Ongoing monitoring is required to ensure that stray rates remain low for SAB Chinook. Opportunities for development of domestic brood stocks with select traits for size, return time, and low stray rates should continue to be explored.

6. Efforts to regularly apply coded wire tags (CWT) for assessment are laudable, but there is concern that given the survival levels quoted, the numbers of tags applied appear to be marginal. Is there a statistical basis for the numbers and what questions are they designed to address?

ISRP Evaluation
The report presents no evidence of a statistical basis for determining the number of tagged fish released at each site and variances of the estimates are not provided. Nor do the sponsors statistically evaluate the precision of the population parameter estimates that the number of fish currently marked will afford. The report states that the number of tags was limited by budget constraints, and that high harvest and sampling rates compensate for the marginal number of tagged fish released. Supporting this contention, the percent of tagged fish in the catch was relatively high, ranging from 15% to 88%, with most returns greater than 25% (Table 3.1). Testing of sample size requirements from recent results might assist future assessment and reduce costs.

The project sponsors need to explain why coded-wire tags were the stock identification method of choice for this project. One hundred percent marking of SAFE salmon could be achieved using relatively inexpensive thermal otolith marking techniques, which would reduce uncertainty in run reconstructions and estimates of stock composition, SARs, interceptions in ocean fisheries, and straying.

7. Treatment of the test fishery is technically inadequate in determining if a stock of concern was present and at what frequency. If the sole basis for this determination is CWT recovery, then the test fishery may not adequately sample for these rare recovery events.

ISRP Evaluation
The report provides a reasonably detailed discussion of test fishing activities. Test fishing has been conducted for 12 years at different select area locations and seasons. Its purpose was to determine fishing boundaries, season lengths, increase recovery of coded wire tags, and to assess catch of non-target stocks at each site. For the first several years that fishing occurred, 100% of the catch was sampled at each site. This intensity of sampling was made possible by mandatory catch inspection. Data collected from the test fishery should be made available widely.

Detailed Comments

Comments on Methods (Question 1)

There is a lack of quantitative estimates of the actual number of smolts released from the facilities.
A difficulty in interpreting the data produced by the SAFE program is a lack of quantitative estimates of the actual number of smolts released from the facilities. These estimates are fundamental in determining survival rates from smolt to adult. The report did a sufficient job of describing the fish culture strategies and noting the losses of juvenile fish to disease and predation. However, the numbers of smolts initially introduced into the SAFE net pens (perhaps

subtracting mortalities that were observed) are used as an estimate of the number of smolts released into the estuary after rearing. Apparently no effort was made to estimate the numbers of fish that actually survived to be released (i.e., the number stocked into the pens minus all mortalities during pen rearing), even though there were circumstances where losses were believed to be high. The current method of determining smolt releases probably overestimates releases and leads to point estimates for survival that may be inaccurate. Perhaps a more accurate method of estimating releases may produce survival rates even higher than reported.

The stock composition and biomass of the harvest cannot be established based on the data provided.
The report presents an inadequate explanation of how the numbers of fish harvested was estimated and calculated. This data is essential because the estimate of fish harvested is the basis for determining the primary benefit of the program. The report provides a general framework for sampling a portion of the harvested fish to determine the age and weight distribution, and then phone and buyer surveys to obtain data that is then converted into numbers of fish harvested. No data are actually provided that facilitates independent verification of the estimates. An example of the algorithm used and data from the surveys would have been helpful. Further, only a point estimate is provided.

The methods for forecasting runs (page 36) are described but no actual data or examples are provided, and there is no citation as to where the data can be found.
For example, paragraph 2 of the section on Run Size Forecasts states "predicted returns of spring Chinook returning to Oregon select areas were forecast based on average predicted Willamette River Basin spring Chinook survival rates applied to site-specific SAFE smolt releases." No citation is provided to inform readers where these survival rates can be found, or what they were. The third paragraph of this section on estimating the fall Chinook run is not adequate for a reviewer to clearly understand what was done.

The report needs to describe the stock characteristics that were used to distinguish SAFE, lower river, and upriver stocks using VSI.
Visual stock identification (VSI) was one method used to distinguish upriver and downriver stocks. The report needs to describe the stock characteristics--the visual cues-- that were used to distinguish SAFE, lower river, and upriver stocks using VSI. In the report, the sponsors simply indicate that "experienced" individuals made the VSI determinations without stating how this was done. The report should indicate what individual stocks can be identified? The report should provide validation study results and methods for correcting errors in estimates using this method. Why aren't genetic stock identification (DNA) techniques used to identify a sample of non-SAFE fish?

In general, methods used to estimate ocean catches of SAFE salmon and to identify non-SAFE salmon stocks are not adequately described, and statistical methods are inadequate (e.g., no estimates of variance in point estimates).
The report does not describe which specific ocean fisheries are included in the "ocean" category? For example, does this category include catches of coded wire tagged salmon by US West Coast and Alaska commercial groundfish trawl fisheries and ocean salmon fisheries (commercial and recreational) in Alaska and British Columbia?

Methods to determine the catch in the Select Area Fisheries were not specific enough, and no data was actually presented to validate the estimates.
The numbers and biomass of fish reported as harvested is an estimate derived from a sampling scheme. The sponsors do not provide sufficient quantification of the error in their estimates. They also do not provide any range (or variance) in the numbers or biomass harvested.

There should be better justification and addressing of assumptions for using coded wire tags rather than other marking methods.
The sponsors did not discuss adequately why they chose coded wire tags as the marking technique for SAFE fish rather than other marking techniques such as thermal marking that would allow greater numbers of fish to be marked.

Rigorous statistical analysis of the data is missing.
The absence of statistical analysis is a persistent problem with this work. Variance estimates are lacking for all point estimates. The problem is especially acute for the experiments conducted as part of Research and Monitoring. These experiments are crucial because the results are intended to be used adaptively to make decisions concerning changes in project operation (e.g., release location, timing, and smolt size).

There are difficulties with application of Smolt-to-Adult (SAR) rates to the SAFE fishery due, in part, to variation in ocean conditions and harvest regimes.
It is well known that SAR's are variable and can be strongly affected by environmental conditions in the ocean and estuary and many other factors. Radtke et al.'s (2006) SAFE economic analysis report states the problem very well: "It is difficult to adopt a SAR to use for a particular brood year in the Study as reflective to what might happen as a result of ocean conditions, harvest management regimes, and other smolt mortality influences. Different periods used in calculating averages will have quite different results. Ocean and in-stream harvest management regimes are set by many overlapping jurisdictions that are responding to international and national treaties, as well as biological conservation concerns. Harvest levels will vary dramatically from year to year. Predicting how harvest management may change geographic fisheries is problematic and only point averages are used for this Study to encompass how adult returns benefit economies through commercial and recreational fisheries."

Radtke et al. (2006) (item 13, p. xvi) conclude: "environmental variables such as ocean conditions and estuary smolt predation greatly affect the realized economic returns from SAFE investments. If the lowest and highest SAR's during the selected 1990's broodstock years are used in a sensitivity analysis, the economic effects vary by a factor of 100." Radtke et al. (2006) suggest that (P. VII-4): "Sponsors can decide if economic outcomes during high risk years (positive PDO index years) are sufficient to justify waiting for the benefits during low risk years (negative PDO index years) is relevant. While sufficient and reliable information is not yet available, future operational planning could even ramp-up or ramp-down production in anticipation of ocean survival."

Comments on Research and Monitoring (Chapter 6)

Avian predation and predator avoidance experiments
The results were not subjected to statistical confirmation (e.g., survival rates for coho that were towed in pens to the mainstem for release versus those that were not towed). Interpretation is difficult because ancillary observations on abundance of predators in the release areas were not made. Although the main predators that were considered were birds (presumably immediate predation from them was in fact avoided because the releases were at night), there may have been fish predators present in the mainstem Columbia River (treatment site) compared to the pen rearing site (control) at Youngs Bay. In addition, there may have been differences in oceanographic conditions at the two locations. Data on these conditions (e.g., temperature, salinity, thermocline level, etc.) were not given.

Is there actually evidence of competition between reared chinook and wild chum and is it sufficient to "stagger" the releases, as the report proposes? No references are given to support the assertion of competition. Perhaps the intent was to avoid predation on chum by chinook? It appears, however, that this aspect of the program was developed at the request of an agency.

Subsurface Feeding Experiment
There may have been an interaction with salinity and temperature in these studies if the pen rearing area was stratified. Although many data on temperature are given, salinity data are few. No statistical tests were given to test differences in survival (Figure 6.3).

Rearing Density Effects Experiment
The report concludes that survival is greater for juvenile fish held at low densities in net pens than those held at higher densities. The results of this experiment are not so clear cut as the report seems to suggest. In only three of the seven years that the study was conducted did there appear to be clear differences in survival of fish held at low densities than those held at high densities (Fig 6.7). Moreover, there was significant interannual variation in survival and stocking densities (Fig 6.8) and conflicting trends in survival that complicated analysis. In only two years (1999 and 2000) did there appear to be reasonably clear differences in survival between the treatment groups. Statistical analysis may have helped in interpretation of the data. The report by Banks (1989) and paper by Ewing and Ewing (1995) are the only citations given for density effects. These papers deal strictly with freshwater hatchery situations and possibly may not be applicable to an estuarine rearing scenario.

Release Timing and Smolt Size Experiments
Further studies are needed to unravel the importance of these variables and the sponsors need to take into account varying ocean and estuary conditions. It is not surprising that the report states (p. 107): "This study was not able to differentiate if density of rearing, size at release, or state of smoltification was the actual causative factor in total survival."

In addition, more information is needed on the relation of the SAFE study to the somewhat similar study being done by NOAA (mentioned on page 106). Bilton et al (1982) looked at the complex statistical analysis needed to unravel time and size effects. It is known that time and size effects interact with ocean survival variables.

Condition and Outmigration Experiments
Data on river currents and tidal amplitude would be useful to interpret migration speed. In some instances, naturally spawned smolts hold in certain habitats and swim against river currents (e.g., Moser et al. 1991). Could this be occurring in the lower Columbia River estuary?

Comments on Environmental Monitoring (Chapter 7)

This section deals with the issue of organic enrichment of the seafloor beneath the net pens. This enrichment could affect ecosystems, possibly influencing other species (e.g., bottom feeding fish such as sturgeon). Perhaps some of the monitoring techniques employed are required as a condition of permitting, but there is a difference between standards on the north and south sides of the estuary -- acceptable mixing zones are specified for Oregon but not Washington. No summary, statistical, tabular or graphic data are provided in this section. It is mainly narrative, but some interesting biological descriptions are given.

Some of the sites clearly have problems with organic enrichment and the SAFE monitoring program seems to be tracking temporal trends. It is not clear if the net pens will be moved from the problem areas such as MERTS and Youngs Bay.

Raw data and many figures are given in the Appendices which describe monitoring efforts quite well, although the statistical comparisons are weak because of the lack of replication of the cores and some methods need clarification. The relatively long term data on temperature, turbidity, and such are some of the few available from the estuary. Are the cores obtained by divers or from the surface?

Population data should be expressed "per unit area" (e.g., m^2) in both Appendices so the data are comparable with other benthic studies. At present, the data in Appendix A are given on an areal basis only. There is a wealth of data here that may be of interest to benthic ecologists working in the estuary.

The narrative suggests differences between sites in remediation from organic enrichment, for example, Tongue Points' MERT facility (possibly slow remediation) versus Tide Point/Bornstein at Youngs Bay (possibly fast remediation). The pens have been (or are currently located) at a total of seven locations. Is there any evidence of cumulative effects or interactions of effects between sites?

Net pen sites seem to be chosen primarily on the suitability for salmon rearing which is to be expected. Some caution, however, is warranted to avoid sensitive locations where permanent damage to benthic habitats may occur.

The comments on instrumentation on page 124 in the main text are confusing. The first paragraph indicates that the sponsors want to stop using an YSI meter, but the next one says they will continue to use "hand held meters" – are these YSIs?

ISRP Conclusions

The select area fisheries project appears successful, providing high and relatively stable harvest rates with minimal impacts on non-target and listed stocks, especially those above Bonneville Dam. The project is consistent with the Northwest Power and Conservation Council's Fish and Wildlife Program and the Bi-State Lower Columbia River and Columbia River Estuary Subbasin Plan. Survival rates of SAFE fish are generally about equal to or better than those achieved at lower Columbia River hatcheries. Harvest of SAFE fish makes up a significant component of the lower Columbia River catch of salmon.

Adaptive management has been a key component of the project. The fishery has been carefully monitored to assess catch and effects on non-target stocks and regulations have been adjusted when deleterious impacts have been observed or anticipated. For example, the use of juvenile rearing and smolt release sites has been discontinued or release facilities have been relocated to lower stray rates while maintaining production. At times, the fishing season has been altered or the SAFE fishery has been closed to minimize effects on non-target stocks. Although the impacts of the fishery on listed stocks appear small at this time, it is critical that rigorous monitoring and evaluation of the fishery continue, especially as the fishery expands.

Some concerns about the report remain. Discussion of methods in the report could have been more comprehensive and complete, and statistical analysis of the coded wire tag and experimental study data was entirely lacking. The report does not present convincing evidence that there is opportunity for expansion of production, and they do not explain why the maximum production goal of 11,300,000 smolts was chosen. Methods for estimation of harvest rates and "impact rate" of select area fisheries on non-target and listed stocks should be discussed more clearly. Because the estimate of harvested fish is not verified, concerns are raised about the validity of the income generated from the fishery. A critical unknown of the SAFE program is potential impacts of large releases of SAFE fish in the future on other populations during periods of prolonged poor ocean conditions.

Recommendations

Recommendation: *Involve a competent statistician in project design and analysis of data.* The absence of statistical analyses is a major shortcoming of the project. Rigorous design and data analyses addressing specific hypotheses are crucial for this project because adaptive changes in the operation of the project are dependent on a clear analysis of the results of various studies and the coded wire tag data. Currently it appears as though experimental results have been interpreted "by eye" and not through careful statistical analysis to test a specific set of hypotheses.

Recommendation*: Extreme caution should be taken in expanding production in future years.* The project plans call for a large increase in smolt production presumably to lead to increased adult returns in future years. With a large increase in production and expected increases in upriver stocks due to restoration activities, the potential for deleterious impacts on non-target and listed stocks may increase. Before production is expanded, a risk management plan should be

developed to anticipate deleterious impacts that could be associated with increased production. At a minimum, the plan should project expected adult returns from increased smolt production (basic model assumptions should accompany such projections). It should anticipate possible impacts on non-target stocks, especially listed stocks, and what steps will be triggered (in a decision tree framework, perhaps) to minimize these impacts. The plan also should assess the degree to which demand for fish will follow from increased production. **Ultimately, continuous monitoring is essential to determine harvest and survival rates, impacts on non-target fish stocks, and stray rates of SAFE fish as production increases. The assumption should not be made that because impacts appear nominal with the present scale of production, they will continue to be so as the fishery expands.**

Recommendation: *The actual number of smolts released from the net pens should be determined.*
Currently the number of smolts released is estimated based on the number originally stocked into the net pens and does not take into account all mortalities that may have occurred during rearing in the pens. An accurate estimate of the number of smolts released is crucial information because this number is used to calculate SAR's. The project sponsors are considering installation of smolt counters to determine actual numbers of releases. The ISRP supports this action, if for no other reason than to validate current methods of estimation of smolt releases. Also, a more accurate assessment of number of releases could improve estimates of smolt-to-adult returns.

Recommendation: *Coho stray rates should be estimated.*
The report does not provide stray rates for coho salmon produced for the SAFE fishery. Stray rates should be estimated, as they are for other species in the fishery. Estimates of stray rates have been important in regulating the SAFE chinook fishery.

Recommendation: C*onsider marking fish using thermal otolith marking techniques.*
Thermal marking would allow a greater number of fish to be marked and could improve estimates of population parameters such as SAR's. Barring this alternative, the sponsors should consider implementation of other mass marking strategies.

Recommendation: *The SAFE project can contribute to furthering understanding of effects of ocean conditions on salmon.*
There should be a strong emphasis on the use of SAFE salmon for scientific research and experiments to quantify and evaluate: (1) the effects of climate, ocean conditions, and ocean fishing on growth and survival of Columbia River salmon, and (2) trophic (density-dependent) interactions between hatchery and wild Columbia River salmon in the estuary and ocean. Such information from well-designed experiments that test hypotheses would add considerable value to understanding the Columbia Basin's salmon populations.

II. IEAB Review of "Select Area Fishery Evaluation Project, Economic Analysis Study, Final Report"

Introduction

The 2005 ISRP/IEAB review identified a number of biological and economic issues and concerns in the "Select Area Fishery Evaluation Project, 1993-2003 Final Project Completion Report" that needed consideration and improvement. In response to the 2005 review, two reports were developed: (1) "Select Area Fishery Evaluation Project, October 1993 to October 2005; and (2) "Select Area Fishery Evaluation Project, Economic Analysis Study, Final Report." Below is the IEAB evaluation of the economic analysis report in terms of how well it addressed the IEAB 2005 comments.

IEAB review comments are presented in three sections: 1. General comments and conclusions; 2. Evaluation of the response to ISRP/IEAB 2005 review comments; and 3. Specific comments on the economic analysis.

General Comments and Conclusions

The economic analysis addresses general economic questions pertaining to the SAFE project in addition to the 2005 review comments. The two general economic questions are whether reducing or expanding the SAFE project can generate economic benefits, and whether the SAFE project is a cost-effective approach to a mitigation fishery in the lower Columbia River.

Does the SAFE project generate economic benefits?
The economic analysis includes a rudimentary estimate of SAFE project economic benefits. Seventy percent of commercial ex-vessel value of landings is taken as a measure of net benefit stemming from the commercial fishery (p. D-3). For the recreational fishery, expenditures are [incorrectly] used as a measure of benefit from increased recreation. The market value of surplus broodstock at hatcheries is adopted as a measure of economic benefit. Changes in these project benefits are measured with and without BPA funding. The estimate of benefits is based upon expected salmon returns which are, in turn, based upon assumed, constant smolt-to-adult return rates (SARs), which implies a proportional relationship between juvenile releases and adult fish returns. In a variable ocean environment these assumed rates may, as the report acknowledges, vary from year to year. Benefits would also be expected to vary with the ex vessel market price for SAFE project salmon. The report does not provide an estimate of expected variability in project benefits.

Project costs appear to exceed reported benefits with or without BPA funding, resulting in a negative net economic value (NEV). It is an open question whether a project with a negative NEV is appropriate mitigation for lost fisheries; perhaps some other configuration could generate a positive net benefit. If mitigation is legally or institutionally required and funds are limited, then the mitigation alternative that is most-cost effective should be selected. The economic

analysis does not address this question in the context of specific mitigation alternatives to the SAFE project.

The net benefits of expanding SAFE project recreational and commercial fisheries beyond present levels are not estimated. If the objective is simply to increase harvests from existing salmon hatcheries, an expansion of the SAFE project might prove beneficial. Increased releases directly from the hatcheries would be an alternative means of increasing fish runs and harvests in mixed-stock ocean and river fisheries. A complete cost-effectiveness analysis would compare these alternative means of expanding the fishery.

An additional purpose of the SAFE project is to serve as a demonstration and test of off-mainstem terminal fisheries. This objective underlies the ten years of experimentation with alternative sites and techniques. The IEAB acknowledges this real, if unquantifiable, benefit of the project's demonstration that the SAFE technique works.

Is the SAFE project a cost-effective approach to a mitigation fishery? The cost-effectiveness of the SAFE project can be judged relative to the cost of other means to accomplish the same ends. A related question is whether some upriver hatchery production might be reduced and the money used to help fund the SAFE project. The economic analysis provides some support for the perspective that the SAFE project allows for more harvest at lower cost per unit of catch than upriver hatcheries. Further, comparison of the costs per additional fish harvested through expanded traditional hatchery production to cost per additional fish harvested via SAFE-style, off-stream acclimation of existing hatchery production would provide the appropriate marginal cost-effectiveness assessment of SAFE versus traditional hatchery production. This would answer the question: what is the trade-off at the margin between SAFE production and other hatchery production?

Traditional hatchery fish mix with ESA-protected fish in the Columbia River estuary and lower mainstem. The objectives of the SAFE project include both increased harvest and reduced incidental catch of ESA-protected fish. The remote site acclimation project effectively pursues this double objective. A cost-effectiveness analysis must compare the costs of alternative means of achieving each objective. However, no realistic and feasible alternative means of achieving both objectives have been designed and pursued. The SAFE economic report suggests that SAFE releases are cost-effective for increasing harvest relative to other hatcheries, but the impacts on catch of ESA stocks are not quantified. Consequently the analysis could not, and did not, provide a complete cost-effectiveness analysis.

Response to ISRP/IEAB 2005 Comments

The economic analysis is generally responsive to the economic issues raised in the 2005 ISRP/IEAB review. The report also provides a large amount of additional information that, although interesting, is extraneous to the central issues. The amount of detail can overwhelm the reader with information that is not central to the questions posed.

The 2005 review comments are listed in bold italics below, followed by the IEAB assessment of the extent to which the economics report addresses the comment.

1. The report does not adequately describe or reference either the biological or economic methodology used in the project. This is a major concern. Without methods of sampling and analysis described and documented, it is not possible to verify reported results and ensure that repeatable procedures can be applied in the future.

IEAB Evaluation
The economic analysis contains much more economic information about the project than did the previous project report. The analysis includes detailed appendices. However, the nature of the documentation and explanations is still a concern. Methodologies and tabulated numerical values are not adequately explained in the text to allow for a clear interpretation or for replication. Instead, the reader is left with questions about specific numbers and assumptions, and must study the tables closely to infer the methodologies used to generate them.

For example, Table VI.1 (p.VI-3) shows calculations of net economic value (NEV) of BPA funding of the SAFE project under different levels of BPA funding. The $49,000 annual loss caused by the loss of BPA funding is mostly an increase in the loss experienced by the coho fishery ($241,000). This loss is not explained. For the coho, releases are reduced from 2,250,000 to 1,900,000 fish, 15 percent, but SAFE coho commercial fishing benefits are reduced from $336,000 to $30,000 or 91 percent. Apparently, the 15 percent reduction in coho production causes a large share of the fish to be re-routed to hatchery surplus. Why? This is not explained in the text. Most of the apparent loss in REI is also caused by this change.

The following are IEAB concerns about the methods. A detailed discussion of these concerns is given later in this review.

- The NEV of a project represents the value of goods and services provided by the project minus the project costs and any other costs incurred in obtaining the goods and services. The economic analysis is to be commended for tackling the difficult task of estimating the NEV associated with harvest of coho and chinook produced by SAFE when reliable and appropriate economic information is very scarce. However, the use of angler expenditures for NEV confuses fishing cost with net economic value.
- Methods of estimating the cost-effectiveness of the project are confused by the absence of comparable alternatives. The absence of realistic and feasible alternatives for achieving SAFE objectives means that the economic report consequently could not provide a cost-effectiveness analysis.

2. "Full implementation" is not specified.

IEAB Evaluation
Full implementation is not defined or addressed in the economics report. However, Section II does explicitly address near-term and long-term planned production of the SAFE project. North et al. (2006) define full implementation as meeting the long-term (> 10 years) smolt production goals of producing 11,300,000 smolts (all species in all sites), an approximately 2.3 fold increase over the current production 4,950,000 smolts (P.141).

The economics report uses the 4,950,000 smolt production in its calculation but does not assess the economic feasibility of a 2.3 fold increase in production under full implementation. The absence of an analysis of the full implementation alternative introduces uncertainty about the economic rationale for expansion of the fishery.

3. The cost-effectiveness of further expansion is not addressed.

IEAB Evaluation
The economic analysis does not address the cost-effectiveness of further expansion of the SAFE project.

Cost effectiveness analysis looks at alternative ways to achieve a given objective and identifies the alternative which achieves the objective at least cost. The economics report casts the analysis as looking at alternative ways to "… maximize harvest access to hatchery production while minimizing impacts to depressed stocks" (page xvi). The analysis first compares SAFE-produced fish to traditional hatchery production in order to determine the most effective production of harvestable fish. Second, it compares the SAFE project to the three alternatives of (1) spilling water to enhance salmonid passage, (2) corner collectors at Bonneville Dam, and (3) the Northern Pikeminnow Sport Fishing Reward Program to see which alternative more effectively minimized impacts on the protected stocks. The second approach implies that these programs are true alternatives both to the SAFE project and to each other – that the fully implemented SAFE program would make it possible to reduce or eliminate spill, to avoid the installation of corner collectors, or to reduce or eliminate payments to control pikeminnow populations. However, without further justification, the IEAB concludes that none of these other programs is likely to be discontinued or reduced even if the SAFE program is highly successful. Consequently, the programs do not represent true alternatives.

As the report notes, if we focus both on providing harvestable fish and on protecting listed stocks, this becomes a classic multi-objective problem. Recognizing both of these competing objectives, while certainly appropriate, means that it does not fit easily into the cost effectiveness paradigm.

4. The report does not provide information on the costs of achieving project goals.

IEAB Evaluation
The economics report provides detailed cost information. However, information on all costs is not available, requiring the analysts to develop best estimates to address information gaps. For example, commercial fishery harvest costs are roughly estimated as 30% of ex-vessel value, leading to the assumption that 70% of ex-vessel value is net benefit. Recreational harvest costs are presented, but are misused as a measure of net economic value. The report does not provide cost information to support analysis of project expansion to "full implementation" levels. In recognition of the incompleteness of cost information, the report notes that NEV estimates should be viewed as "general indicators" for comparing alternatives.

5. Because cost considerations are absent, the report presents gross rather than net incremental benefits.

IEAB Evaluation
The economics report includes available cost information and estimates net incremental benefits to the degree that the data support this estimation.

6. The report does not thoroughly explain how decisions about project modifications are made, and how costs and benefits inform those decisions.

IEAB Evaluation
The SAFE project has no stated economic criteria for making project modifications, leaving the economic analysis without a standard against which to compare economic aspects of project modifications. The report's comparison of "with and without BPA funding" provides an economic assessment of two SAFE alternatives. The report emphasizes that its analysis can help inform future decisions about project modification.

7. At what point will the BPA subsidy be removed and the operation become supported by the commercial and recreational interests? Is the hydropower mitigation aspect expected to continue forever? On what basis?

IEAB Evaluation
The consideration of a "no SAFE project" is incorporated into the analysis. A "no SAFE project" is defined at p. II-5 and assessed for "without BPA funding" in Table VI.1 (P.VI-3). However, there is no explanation of the reasonableness of the alternative "without BPA funding."

The SAFE project is mainly aimed at obtaining greater fishery benefits from the hatchery program, while protecting the survival of threatened and endangered (T&E) species migrating through the Columbia River mainstem. Alternative ways of accomplishing the same outcome, such as increased mainstem harvest with increased wild fish survival at the dams (using structural elements or increased spill), have not been seriously proposed or analyzed. The report's rationale for including $600 million of spill as an alternative to the SAFE program is unclear, since there is no obvious opportunity to trade changes in spill for changes in the SAFE program (up or down). It is also unclear whether state agencies were asked if they would continue to fund specific SAFE activities if BPA funding ended, and if so, at what level.

8. The report does not address the regional impact of the project.

IEAB Evaluation
The regional economic impact of the SAFE project is included in the report. The analysis shows positive economic impacts of the SAFE project on the local economy (two counties); the gillnet salmon fishery is a small, but important (about 7% of total harvest revenues) contributor to the economy of the Astoria/Ilwaco area. The economic impact on the western Oregon/Washington region as a whole is less clear.

In terms of assessing impacts, the analysis does not provide information on the net change in expenditures as a result of the SAFE project: i.e., existing expenditures versus what would have happened if the SAFE project did not exist. The SAFE project is not compared to other projects which could spend the same amount of BPA funds on Columbia River projects; i.e. the impacts of alternative ways for BPA to spend $1.6 million annually. The possibility that additional fishing expenditures in the local area due to the SAFE project might be offset by fewer expenditures on fishing in other areas of the Pacific Northwest is not addressed.

9. The project has no clear statement of economic goals and objectives.

IEAB Evaluation
Economic goals and objectives of the SAFE project center on providing harvestable fish at terminal fisheries. The production of economic value by the SAFE project is referenced in the text of both the project report and the economic report. The project may have an additional "demonstration value" that is overlooked: if harvest objectives can be met in the manner of the SAFE project with minimal impact on endangered species, additional "select fisheries" projects may be warranted.

10. It is unclear how ex-vessel revenues and non-market user values were calculated.

IEAB Evaluation
The appendices of the economic report provide information about these values.

Specific Comments on the Economic Analysis by Section

Executive Summary

It would be useful to have the SAFE project's performance metrics defined. Considering that the SAFE project's goal is to maximize harvest while minimizing impacts of listed stocks, which economic metrics relate to this goal? Various seemingly appropriate economic indicators are presented in Table ES-1, but it is unclear which of these metrics will be considered in SAFE project funding. The lack of clarity regarding specific economic performance metrics is not the fault of the economic analysis but rather a missing element of overall SAFE project design.

The economic analysis should determine if SAFE can meet its biological goal in a cost-effective manner; that is, could some other approach provide more harvest with less impact on listed stocks at a lower cost? SAFE appears to be a cost-effective means of reducing impacts on upriver stocks, but the harvest part of the question is unaddressed.

The net benefits of the SAFE project would be clearer if the report could conclude something about the effect of BPA funding on NEV, REI, and local impacts. It appears that BPA spends 67% of $2.4 million to produce $49K in NEV. From a regional perspective this return doesn't make economic sense, and the report should say so. There may well be reasons in addition to the estimated NEV for BPA to fund the SAFE project.

The report also states that the NEV of the SAFE project, with or without BPA funding, is negative. This should be clearly stated and its implications explained. The statement that the $2.4 million creates $12 million in local income ignores the fact that the $2.4 million expense reduces local income somewhere else, because electricity rates are higher, and diverting some recreational fishing expenditure to the SAFE project area will cause negative income impacts elsewhere in the region.

The statement that hydropower values should be "included in the NEV equation" (Page xvi) should be explained in greater detail.

On point 22 (Page xviii) the report notes that “Recreational fishing is allowed at SAFE net pen fishing areas, but there are only comparatively minor harvests” (estimated to be 1,300 fish). The Report estimates that most of the recreational catch attributable to the SAFE project occurs in the lower river and ocean areas, projected to be 13,900 fish in 2006. The river and ocean catches undoubtedly involve higher rates of incidental catch of ESA-protected species, and this should be weighed against the recreational benefits.

I. Introduction

Accounting for total SAFE-related costs is described as a major task (I-3). The analysts used CY2006 intended release counts for the cost analysis and a range of SAR’s associated with 1990’s broodstocks for the economic feasibility analysis (I-4). The authors describe why they made this assumption, but a question remains as to its appropriateness. How would results change if different years were used? How would results change under full implementation?

The introduction obliquely addresses the question of alternatives to the SAFE project (to support a cost-effectiveness analysis). It lists a number of alternative approaches, then concludes that SAFE is so unique that it cannot be compared to any of the listed alternatives. However, later in Section VI the comparison among alternatives is made. This is confusing.

The statement (Page I-6) “This study is to provide recommendations about how commercial fisheries can maximize the economic value derived from the SAFE project if it is to continue” is unclear.

II.B. SAFE Production

The 2005 review asked at what point will the BPA subsidy be removed and the operation become supported by the commercial and recreational interests? Is the hydropower mitigation aspect expected to continue forever? On what basis? The report answers these questions as follows “The final phase does not assume a self-sufficient funding mechanism (II-3).” The **“**No BPA funding” scenario is that all SAFE-related hatchery production with BPA support would go away and that hatchery production with non-BPA support would continue (II-5).

IV.C. Recreational Fishing

On page IV-13 the report states: "There is a significant lower Columbia River boat and bank recreational fishery" and on page IV-16 states "The ocean and in-river fishing trips were mostly in mixed stock fisheries where SAFE stocks are only a part of abundances. Recreational fishing is allowed at SAFE net pen areas, but only comparatively minor harvests have been recorded." The reference from North et al. (2006) indicates that 1,300 fish were in the recreational fishery at the off-stream SAFE site, while the river and ocean fishery expands the total SAFE-related catch to ten times that amount (page IV-16). In evaluating the recreational fishery benefits from the SAFE project, the report should be comparing the expected recreational catch of hatchery-origin salmon with and without the SAFE net pen operation. To the extent that the SAFE project increases survival of smolts, it does increase available recreational catches. But the report does not provide a useful estimate of this increase. Instead, it simply reports estimated overall catch of SAFE-related fish, leading to an incorrect inference that none of these fish would be harvested in the river and ocean fishery without the SAFE project.

VI. Economic Analysis

The NEV of a project represents the value of goods and services provided by the project minus the project costs and any other costs incurred in obtaining the goods and services. The economic analysis is to be commended for tackling the difficult task of estimating the NEV associated with harvest of coho and chinook produced by SAFE when reliable and appropriate economic information is very scarce.

To assess the NEV from commercial fishing, the report uses a rough, rule-of-thumb that net earnings are 70% (midpoint in the 50-90% range estimated in other studies) of the gross sales value of fish harvests attributable to SAFE. For the much smaller recreational fishery, the report apparently uses the expenditures of anglers on fishing trips as a proxy for the NEV of recreational fishing. While the rule-of-thumb for commercial fishing NEV is an acceptable approach, the use of angler expenditures for NEV confuses fishing costs with net values. To better estimate NEV for recreational fishing of SAFE-produced salmon, a special recreational valuation study may be needed to estimate total value of the recreational harvest. Then the costs of recreational fishing would be subtracted from the gross value (as in the commercial fishery NEV estimate).

NEV is calculated for what might be considered the status quo (also used as the baseline alternative), and secondly, a hypothetical situation for no BPA or equivalent funding. The full implementation scenario is not analyzed. Status quo would mean that approximately two thirds BPA share would continue, smolt release levels would be about 5 million, and average SAR's for 1990's brood years would apply (VI-1). Under the "No BPA funding" alternative, "BPA support would go away and hatchery production with non-BPA support would continue as traditional hatchery releases." The meaning of "Hatchery production is to replace lost habitat due to hydropower development, so hydropower benefits and dam construction costs could be included" (page VI-1) is unclear.

Table VI.1 needs further explanation. Withdrawal of BPA funding is assumed to cause a 15% drop in coho releases, a 25% drop in the SAFE cost of producing the released coho, and a 91% decrease in the commercial harvest benefits associated with coho. Apparently, the huge decrease in commercial value of coho releases occurs because, without the off-stream harvest at the SAFE site, most of these fish would return as surplus spawners to the hatcheries, where they have significantly lower economic value. The logical steps here are not explained well, and the value per fish at different points in the fishery (ocean fishery, river fishery, SAFE site fishery, hatchery surplus) should be clearly displayed.

The analysis does not thoroughly discuss trade-offs among alternatives, which are the heart of this kind of economic question. For example, what does the cost per harvestable adult tell us about allocating more or less money to SAFE versus other "comparable" hatcheries?

Tradeoffs among alternatives are implicitly addressed in the analysis' assessment of cost-effectiveness. The economic analysis uses two different metrics to look at SAFE cost effectiveness. First, it uses cost per harvested adult (Table VI-7) to compare SAFE projects to traditional hatchery production to see which alternative more effectively produces harvestable fish. Second, it uses cost per one percent saved juveniles (Table VI-8) as a metric to compare the SAFE project to the alternatives of spilling water to enhance salmonid passage, corner collectors at Bonneville Dam, and the Northern Pikeminnow Sport Fishing Reward Program to see which alternative more effectively minimized impacts on the protected stocks.

The second approach implies that these programs are true alternatives – that the fully implemented SAFE program would make it unnecessary to continue spilling, to install corner catchers, or to control pikeminnow populations. However, none of these other programs is likely to be discontinued even if the SAFE program is highly successful, so they are not truly alternatives.

As the economic report notes, if we focus both on providing harvestable fish and on protecting listed stocks, then this is a classic multi-objective problem. Recognizing both of these competing objectives, while certainly appropriate, means that it does not fit nicely into the cost effectiveness paradigm.

It appears that a large portion of SAFE project benefit comes from the conversion of surplus hatchery returns to harvestable fish (Table VI-2). The present (BPA funded baseline) program appears to have reduced the hatchery surplus by more than half (from $143 million to $57 million) compared to the alternative (without BPA funding). Since commercial and recreational harvests have a much higher value per fish than hatchery surplus, the increased value of harvestable fish must be much larger than the $86 million reduction in hatchery surplus.

The problem arises when these figures are used to extrapolate these benefits to an expansion of the SAFE program in the future. Since the present program has already been successful at moving many of the hatchery surplus fish to the "catch" category, any incremental expansion of the program will be less able to generate value from further reductions in hatchery surplus. The report should document the extent to which further large reductions in hatchery surplus are achievable. If reduced surpluses are not likely to result from increased SAFE production, it is

reasonable to anticipate that any expansion of the SAFE program will show higher costs and lower net benefits per harvestable fish than the current increment of the SAFE program attributable to BPA funding.

VII. Study Conclusions

The conclusions section uses various terms to represent the analysis, including “cost-effectiveness”, “economically feasible”, and “winning solution.” A single consistent characterization would be less confusing. The overall conclusions on p. VII-12 are not entirely in line with the economic analysis; for example describing a program that produces negative NEV (with or without BPA funding) as a "winning solution to several problems."

Appendix C Salmon Market and Marketing Opportunities

The changing nature of the market for salmon is well described in Appendix C, but this information is not incorporated into the main analysis.

Appendix D: Economic Analysis Methods and Factors

The section on commercial fishing (D-3 - D-4) seems to mix marginal and average economic concepts in the development of the "percent rule" for NEV calculations (i.e., NEV of commercial fisheries ranges between 50-90% of ex-vessel price). For example, the first full paragraph of D-4 begins "[i]n periods of reductions". Reductions from what? Current level? Some counterfactual situation? The first two sentences in this paragraph suggest a stepped NEV function: if the number of fish caught increases (from something), then NEV should be assumed to be 50% of ex-vessel price; however, if the number of fish caught falls (presumably from the same "something"), then NEV should be assumed to be 90% of ex-vessel price.

Selecting a midpoint in the 50-90% range, the economic analysis assumes a NEV of 70% of the ex-vessel price. The implications of this assumption are not well understood. How robust are the analytical conclusions to this assumption? How would the results change if the analysis used 90% or 50% instead? If the answer is "a lot", then that should be brought to the reader's attention, especially because the overall conclusion of the report is that it's a good idea for BPA to spend ratepayer money on this project to create local income.

It is unclear what the percentages in Table D.1 represent.

References: Reports reviewed by ISRP and IEAB

North, J. M. Miller, J. Sewall, T. Jones, A. Dietrichs, T. Miethe. 2006. Select Area Fishery Evaluation Project: 1993-2005 Final Project Completion report. Prepared for Bonneville Power Administration, BPA Project #199306000, ODFW Contract #0004121, WDFW Contract #0004131, CEDC Contract #0004129, April 2006.

The Research Group. 2006. *Select Area Fishery Evaluation Project, Economic Analysis Study, Final Report.* Prepared for Bonneville Power Administration, Washington department of Fish and Wildlife, and Oregon Department of Fish and Wildlife. November 2006.