Review of the IEP Delta Juvenile Fishes Monitoring Program and Delta Juvenile Salmonid Survival Studies

Interagency Ecological Program (IEP) Scientific Advisory Committee (SAG)

June 20, 2013 Summary Report

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Introduction

The Interagency Ecological Program's Scientific Advisory Committee (IEP-SAG; Appendix A) was commissioned to provide a comprehensive programmatic technical review of the IEP's Delta Juvenile Fishes Monitoring Program (DJFMP) and Delta Juvenile Salmon Survival Studies (DJSSS). The purpose of the review was for this IEP Review Panel ('Review Panel') to determine if the DJFMP/DJSSS are meeting the present goals and objectives, robust enough to answer future questions, and providing information that can be integrated to facilitate the protection, restoration, and management of naturally produced salmonids and other native species in the Central Valley of California.

This IEP-SAG Review Panel was requested to address ten basic questions:

1. Are goals and objectives explicitly clear and identified?
2. Does the sampling design, techniques and types of data gathered help answer each study question/objective?
3. Are the programs providing adequate sampling in time and space to fulfill study objectives?
4. Are the monitoring programs generating sufficient information to meet ESA compliance? Can the programs be used to assess ESA trends and abundance?
5. Do the programs generate information on other species useful for understanding ecosystem processes?
6. Have the programs identified data limitations?
7. Is data disseminated to users in readably useable formats and is sufficient time periods?
8. Are the programs analyzing the data in a manner that produces accurate interpretation?
9. Are reports or peer-reviewed publications completed on frequent basis? What the measure for success?
10. What recommendations can be made to improve the program?

In considering these questions, the Review Panel was expected to assess the DJFMP/DJSSS program goals and objectives (which are predominantly focused on salmon and steelhead [*Oncorhynchus mykiss*]; see below) and the conclusions and changes from past reviews. We were to specifically focus on how the IEP DJFMP and DJSSS fit into other salmon/steelhead monitoring conducted and coordinated through the IEP Salmonid Project Work Team in the Central Valley. And, we were expected to consider both the questions the programs are presently working on and proposed questions that will likely be asked in the future. The detailed scope of the Review Panel's mandate is provided at the IEP website: http://www.water.ca.gov/iep/docs/051112_DraftReviewScope.pdf

Considering the DJFMP and DJSSS together as a somewhat integrated program, the six objectives of the program are to:

- document the long-term abundance and distribution of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in the Delta;
- comprehensively monitor throughout the year to document the presence of all races of juvenile Chinook salmon;
- intensively monitor juvenile Chinook salmon during the fall and winter months for use in managing water project operations (Delta Cross Channel gates and water export levels) on a real-time basis;
- document the abundance and distribution of steelhead;
- document the abundance and distribution of non-salmonid species; and,
- identify the factors influencing salmonid survival in the Delta such as route, flow, exports, and other covariates (DJSSS).

In the following review report, we have integrated these objectives within our response to the ten questions that the IEP-SAG was requested to address.

The primary source of review material was delivered to the IEP-SAG on 20 May 2013, in the form of the Dekar *et al.* 2013 draft “Background Document”. This was accompanied by an extensive bibliography and digital copies of many of the critical supplemental documents that describe the history and results of those programs.

The formal review occurred on 4-5 June 2013 in Sacramento, California, including a summary of the Dekar *et al.* 2012 Background Document by each objective, an overview of past use of DJFMP information, including recent examples of how data is being used for modeling and management, and what is needed in the future. Appendix B is a copy of the draft agenda for that meeting.

The IEP-SAG review comments and recommendations in this document will be provided to the authors of the draft Background Document. Because it may contain suggestions on what might have been missed in the draft Background Document or what additional analyses should be conducted and comments on the proposed recommendations, responses will be incorporated into a revised, final Background Document that will be delivered, with this IEP-SAG report, to the IEP Management Team.

Review Comments and Recommendations

Preamble

The IEP-SAG panel emerges from this review of the DJFMP and DJSSS convinced that they are important programs the momentum of which the Bay-Delta community cannot afford to lose. There are many emerging findings, especially those resulting from integrated monitoring and special studies, that advance the program’s goals and objectives. It is, however, an opportune time for transition to move the programs toward a better understanding of how the Bay-Delta “works” or doesn’t “work” as a system to support salmon, steelhead, and other key species in a progressively changing estuary. In our review, it was not uncommon for us to question whether the program was unwittingly producing “Type III errors” (providing the right answer for the wrong question). It is time for this program to undertake a re-design of not only its study design, methods and analyses, but also the basic goals and objectives. The program needs to advance beyond descriptive data gathering and correlative analyses, to a more systematic, process-based knowledge of fish responses to a changing Bay-Delta.

The best monitoring programs revisit their overall goals and design every 10 to 15 years with the objectives of finding efficiencies built from the knowledge gained and moving toward understanding. Much precedent says this can be done without losing the momentum of time series monitoring. The value of the incredible IEP monitoring long-term time series is irrefutable, and backward compatibility is essential, but the IEP-SAG believes that it is time to revisit goals and objectives in terms of changing needs, system changes and future development and climate change. In particular, while we heard from several presentations that the data generated by the program supports various management decision processes, there still appears to be a need to re-examine whether, how, when and where DJFMP and DJSSS data will ultimately contribute to ESA salmon recovery?

Although the Background document and accompanying materials were a considerable mass of information to absorb in a couple of weeks, not to mention the continued presentation of additional materials throughout the review, the IEP-SAG was uniformly impressed the quality and insight of the Report, the preparation and presentations, and the prospects and impetus for the program's evolution. In particular, new studies such as acoustic route and survival estimation, genetics, and modeling are particularly impressive and have the potential to contribute measurably to the program's redesign.

There is a wide range in the quality and depth of analysis conducted by the DJFMP. We organize our discussion around survival studies, beach seine and trawl data salmon data, non-salmonid data, and integrated modelling efforts. We end our discussion with a broader view of issues related to interpretation of data from the DFJMP. We acknowledge that the Review Panel may have gone somewhat deeply into the "weeds" in some cases and not had a full understanding of the constraints and institutional mandates and arrangements; so, we encourage feedback on our interpretations.

IEP-SAG Review Question Responses

1. Are goals and objectives explicitly clear and identified?

The program goals and objectives are to some degree inconsistent in their interpretability. Some of the stated objectives are vague, which makes it difficult to identify the real intent and adequately assess how well the methods are meeting the objective. For example, the first objective is to "Document the long-term abundance and distribution of juvenile Chinook salmon in the Delta." Based on the background documentation, we would interpret that a key, emergent DJFMP goal is to understand how salmon distribution and abundance affect or relate to the within-Delta or early-ocean survival of salmon (and, similarly, steelhead and key non-salmonid fishes) in the Delta. Salmon distribution and abundance are certainly two response variables that could be used, in part, to address that goal. But, it is not clearly stated why is it important to determine the distribution and abundance of juvenile Chinook in the Delta and it is not clear if the focus in on natural and hatchery fish or both.

Objectives need to be clear and attainable and unambiguously address the overall program goal, along with other programmatic mandates, such as ESA and water quality standards. What are the broader programmatic objectives? For instance, is the broader programmatic objective to determine if, and how, juvenile Chinook salmon use of and survival through the Delta is changing? Therefore, we suggest revisiting both the intent and the wording of the program objectives.

While consistent with overall IEP goal, adequate synthesis, interpretation and evolution of the program to address the actual causal mechanisms of survival and performance is lagging because of the continued uncertainties associated with abundance and distribution. Absolute abundance does not appear to be the critical index; relative abundance to management questions (e.g., route, etc.) is sufficient? But, as discussed below, key uncertainties could lead to bias in trends over time: inadequate understanding of gear efficiency, unrepresentative habitat sampling, and restricted timing. As presented, the program appears overly focused on sampling through time and space and not yet adequately focused on estimating their bias and precision and ensuring adequate representation of available habitats.

2. ***Does the sampling design, techniques and types of data gathered help answer each study question/objective?***

3. ***Are the programs providing adequate sampling in time and space to fulfill study objectives?***

Estimating the abundance of fish populations, or quantifying relative changes in abundance over space and time, can be very challenging. John Shepherd, a well-known stock assessment biologist, once said “counting fish is like counting trees-except they are invisible and they keep moving”. The Delta is a large and hydrologically complex system. There are a number of species and races of management interest with diverse life history characteristics. Reliably estimating spatial and temporal trends in these circumstances is an extremely challenging endeavor, perhaps more so than in other major freshwater restoration efforts occurring in the US (e.g., Columbia River, Trinity River, Colorado River in Grand Canyon). The IEP-SAG, with considerable help from DFJMP staff, have identified some significant limitations in the existing program. This should come as no surprise given the challenging setting.

There are five key issues that affect the reliability of the DJFMP to track trends in abundance of Chinook and other species due to evident uncertainties in the underlying assumption that sampled sites represent fish distribution and abundance through Delta, unknown catchability and in the process for scaling/expanding density:

1. error in estimating trends in abundance of wild-origin Chinook from a population that is dominated by hatchery-origin fish;
2. error in race assignment for Chinook; the length-at-date (LDC) method can provide relatively accurate assignments for some groups in some months, but there can be considerable uncertainty in other cases;
3. potential bias associated with site selection, variation in habitat use over space and time, and variation in detection probability;

4. potentially poor precision due to high variation in abundance and detection probability over space and time; and,
5. failure to account for variation in abundance unrelated to methodology and site selection, i.e., interannual variation in smolt or hatchery production or in-river mortality, can lead to inaccurate interpretation of abundance patterns.

Origin & Life History Considerations

Both the DJFMP and DJSSS need to recognize the need and challenges to take Delta data into whole life history context of Pacific salmon, which the IEP-SAG recognizes is not a trivial task across the multitude of monitoring and special studies that are supposedly addressing factors limiting survival and condition of (particularly ESA) salmon rearing in and moving through the Delta. The program needs to: (1) address the basic needs to differentiate hatchery from wild salmon; (2) incorporate more detailed life history analyses, such as otolith analyses, to refines those estimates; and, (3) place the catch/abundance estimates in a broader context of the entire life history—spawner abundance, fry-smolt production, etc.

Error in hatchery-wild origin is not adequately addressed in DFJMP reporting. Adipose fin-clipped Chinook are removed from the catches, however, this adjustment does not account for the fact that only a fraction of hatchery fish have been marked, and that this fraction has varied among hatchery release groups over space and time. Failure to account for such changes could lead to substantial bias in trends in wild-origin Chinook abundance as inferred by DJFMP reporting. The program needs to report the catch or catch rate of wild-origin Chinook by incorporating the best available estimates of the proportion of hatchery fish in the catch. For example, if current hatchery practices clip a constant 25% of releases, than the hatchery catch should be based on a 4-fold expansion of clipped fish, and this expanded total should be removed from the total catch to estimate the wild catch. Reported variance estimates need to reflect the uncertainty associated with hatchery and wild assignments, and assumptions need to be clearly documented. A statistician may be helpful in developing the methodology for estimating these adjustment factors and variance calculations.

The program may consider taking regular otolith samples to derive an empirical estimate of the hatchery contribution (Johnson-Barnett *et al.* 2007). We recognize that otolith analysis is likely beyond the scope of the current DJFMP budget, however ESA goals and monitoring objectives focus on wild fish. In the absence of addressing this issue in the future, the DJFMP needs to clarify that it currently monitors only abundance of the combined wild- and hatchery-origin stocks, and ensure that this objective is compatible with goals of the larger Bay-Delta program and ESA requirements.

Despite the program objective of tracking trends in Chinook abundance by race, the program presently can only deliver trends for the species as a whole, rather than by race. Error associated with the assignment of Chinook race based on length-at-date criteria has been recognized for a long time (Hedgecock 2002), yet the reported variance estimates of catch rates by race by DJFMP do not reflect this uncertainty. At a minimum the reported trends in catch rates by race need to be adjusted based on the known biases in the LDC method, and variance estimates need to reflect the uncertainty in race assignments. The reported trends may provide a misleading picture of the relative changes in abundance over time for winter and spring-run, and certainly underestimates the variance in these trends. It is clear that abundance of spring-run Chinook salmon is being substantially over-estimated. Winter-run designations appear more robust but there is evidence of spatial variability in incorrect run designation (Sacramento error rates < Chipps Island trawl error rates). Clearly, the DJFMP is on the path for correcting this, and sufficient information is available to provide preliminary corrections prior to the next reporting cycle. A statistician would be helpful in developing the methodology for estimating these adjustment factors and variance calculations.

Efforts should focus on determining if genetic information can be used to develop or refine other methods to identify run (such as the "winter-run wedge"). If not, which is likely the case for spring-run Chinook salmon, long-term genetic sampling in strategic and appropriate locations may be needed, depending on the specific objectives of the program in the future. DJFMP is currently conducting genetic work to address this issue and initial evaluations indicate the potential for significant overestimates of the abundance of winter- and spring-run, and underestimation of fall and late fall-run Chinook in Chipps Island trawl data.

If sampling to differentiate wild from hatchery or different races is beyond the scope of the DJFMP budget, the objectives of the program need to be changed to reflect the fact that there is high uncertainty in juvenile salmon distribution and abundance for some time and areas.

Distribution & Abundance

Understanding potential issues associated with bias and precision begins with the recognition that only a small fraction of the population of interest is sampled by DJFMP efforts. That is, catch (C) represents only a fraction of the total abundance (N), as represented by the equation,

$$C = q * N$$

where, q is often referred to as the catchability coefficient or detection probability. If q is assumed to be constant over space and time, catch provides a reliable index of abundance. Currently, DFJMP reports catches or catch rates that do not account for potential changes in q, and in doing so, implicitly assumes that q is constant over space and time. Violation of this assumption, which is likely, would lead to substantial biases in reported trends.

The overall detection probability of a population to sampling is the product of multiple components as described by the following equation,

$$q = a/A * q_s * q_h$$

where 'a' is the total area (or shoreline length or trawl volume) sampled across all efforts within a strata (e.g., month of March across all seine sites), 'A' is the total area of useable habitat for the population of interest (e.g., total shoreline area of the Delta), q_s is the proportion of fish captured within a sample site (or tow) per unit of effort (within-site detection), and q_h is the proportion of the population in the habitat type that is sampled (across-site detection, e.g., the proportion of Chinook in unobstructed low-angle habitat types that can be sampled by beach seine). 'a' and 'A' can be determined from field- and GIS-based mapping, respectively. These values can be treated as constants and only need to be estimated if an absolute abundance for the total study area (Delta) is required. In our view, absolute abundance estimates are not essential to meet DFJMP objectives or to support modelling activities, so no further discussion of this term is required.

Changes in site characteristics, fish size, density, behavior, and physical conditions during sampling (turbidity, flow, depth, etc.) can have substantive effects on within-site detection probability (q_s) and can be estimated by standard mark-recapture or depletion methods (e.g., Peterson *et al.* 2004, Rosenberger and Dunham 2005). In discussions with the SAG, the term ‘gear efficiency’ was used, and in most cases it was referring to within-site detection probability. As the equation above illustrates, ‘gear efficiency’ is only one element in the determination of the overall detection probability, and a broader discussion is warranted.

DJFMP is planning on estimating ‘gear efficiency’ that is, q_s, at beach seine sites by depletion methods. Analysis of depletion data almost always assumes that fish are equally catchable among depletion passes which is usually a bad assumption as more vulnerable fish are captured in earlier passes (Hilborn and Walters, 1992, Korman *et al.* 2009, Peterson *et al.* 2004). As a result, the method usually overestimates q_s and underestimates abundance. Mark-recapture techniques, where different marks are applied on each pass, do not require the assumption of equal detection probability among passes, and will lead to less biased and more precise estimates of detection probability. However, mark-recapture efforts are a little more involved and take more time to implement in the field than the simpler depletion approach. As well, marking fish may require a change to ‘take’ permits because marked fish are counted as part of the take. However, this does not necessarily need to be an impediment in the long term, considering that adipose fin-clipping and use of CWTs are the basis for management of Chinook and coho fisheries over the entire west coast, and marking programs are routinely conducted on endangered species throughout the US (e.g., Coggins and Walters 2009).

The DFJMP plan is to obtain a representative sample of q_s estimates from multiple beach seine sites through time, and to develop models which use physical and biological covariates to explain some of the variation in q_s. If these models are reliable they could be used to predict q_s in sites where a single pass of effort is applied (e.g., Peterson *et al.* 2004). If covariate models are imprecise or have little support, the variance in q_s across sites can at least be used to provide more realistic estimates of uncertainty in reported trend indices (e.g., Wyatt 2002). Such two-stage designs are efficient and have been successfully applied in other systems (Hankin 1984), and modern statistical techniques can be used to properly account for differences in uncertainty at single- and multi-pass sites and can integrate that uncertainty into a single estimate of density or relative abundance (Wyatt 2002 and 2003) for an area or time of interest.

Estimation of q_h, the proportion of the population within the habitat type that is sampled (e.g., low angle unobstructed beaches and boat ramps), is a critical parameter to estimate for the DJFMP. However, limitations of inference from beach seine are readily apparent and the justification for that design is unclear: Why were these beach seine site chosen? Are they considered representative of discrete regional segments of juvenile salmon paths through Delta? The present rationale appears to be that current logistical and budgetary constraints, and restriction of effective sampling of nearshore habitats in the Delta to beach seines, preclude the random selection of sampling sites and the use of alternative sampling techniques.

The IEP-SAG believes that this sampling design is not serving the program's goals and objectives. Non-random sites likely do not represent the Delta as a whole; they could perhaps be used to detect several orders of magnitude differences/change, but will likely not be useful for assessing habitat use that could contribute to restoration strategies. As a result, there is large uncertainty about whether the selected sites represent trends for the larger population across all shoreline habitats over space and time. It is not hard to imagine situations where changes in the density of the target species, predator species, food supply, or physical covariates, change the distribution of fish in these open low-angle sites relative to others, and such a shift would lead to potentially very misleading trends (Rosenfeld *et al.* 2005). For example, an expansion of submerged aquatic vegetation, if avoided by Chinook salmon, would increase the proportion of the population in the open habitat types that are currently sampled. Under a situation where the overall population is declining, this habitat shift would make the index appear stable and mask the decline. Such hyper-stable dynamics have led to major fisheries collapses (collapse of Northern Cod fishery) and are one of the most pressing concerns in the evaluation of long-term trend data. A similar dynamic could apply to the trawl sites with respect to offshore-onshore use. It is likely that larger fish are moving past the Chipps Island trawl site through the center of the channel that is sampled, and that smaller fish may be migrating closer to shore. If this is the case, the trawl data provides an incomplete picture of the salmonid output from the Delta. Further, changes in physical and biological (density) conditions could change the offshore-onshore distribution over time and lead to misleading trends.

Non-random site selection in long-term fisheries data sets is an unfortunately common situation. For example, studies on Oregon coho provide a compelling story of the potential consequences of non-random site selection and provides an example of applying corrections to prior non-random surveys based on subsequent randomized sampling. As summarized by Jacobs and Nickelson (1998), spawning surveys for coho salmon in Oregon were conducted in standard index areas to assess trends in the spawning escapement of Oregon Coast Natural production. However, a review concluded that the method of survey site selection was probably the most serious source of bias because of evidence that survey sites were predominantly located in "better than average" spawning habitat and, hence, led to serious over-estimates of spawner abundance. To improve the methodology, the authors proposed a sampling plan designed to reduce survey site selection bias and to provide an estimate of the precision of the escapement estimate. The recommended sampling plan incorporated a stratified random sampling scheme, where, within geographic sampling units, survey sites are randomly selected from the estimated available miles of coho salmon spawning habitat. The authors also discuss the challenges and potential consequences of randomly sampling highly aggregated populations.

Often under these situations, the original site selection was made by biologists looking for sites that would have high densities of fish based on the perception that there is little utility in sampling places that are likely to have low fish densities. 'Non-random sites often represent a 'high-graded' sample of all habitats. There is much ecological theory and evidence which suggests that abundance in such sites will be less responsive to population-wide changes in abundance because quality habitat is preferentially selected by organisms to increase their growth and survival rates (Gibson *et al.* 2008). As a result, a dataset based on a high-graded sample is much more likely to exhibit hyper-stability and provide a misleading representation of trends in abundance. Thus, the non-random selection of sites used in the DJFMP seining program is a major concern, and an investigation comparing reliable estimates of abundance in these sites relative to a representative sample is strongly recommended.

Estimation of across-habitat differences in true abundance and detection probability requires sampling other habitat types beyond the ones currently sampled by beach seine and trawl nets. Boat electrofishing would be a highly effective and efficient gear to sample these other habitat types. Such an effort would be involved and be a major addition to the program. A sufficient sample size of single pass boat electrofishing sites, combined with a smaller sample of mark-recapture sites, would be required (e.g., Korman *et al.* 2011) but will require additional or reallocated resources for DJFMP. Overall bias resulting from non-random variation in q_h and q_s through time and space depends on the relative variation in each component. In our view, non-random variation in q_s at beach seine sites is less likely to result in major biases in trends in abundance compared to non-random variation in q_h (due to hyper-stable mechanisms described above). Thus, it may not be worth increasing field efforts to measure only within-site detection probability if there is no possibility of estimating across-site variation. It is less obvious whether this is as much of a concern at the trawl sites. DJFMP should clearly think through these issues before embarking on a significant effort to estimate within-site detection probability at beach seine sites as currently planned. A staged plan to address both these detection issues needs to be developed. In the absence of such an effort, objectives and the presentation of results from the program need to be revised. Based on the current program, trends from beach seine sites provide an index of abundance at non-random and potentially unrepresentative sampling sites. This limitation may mean the program is only capable of detecting gross changes in abundance. The ability of this index to accurately track subtler trends in the target population (i.e., the Delta) is unknown.

The final issue to consider with respect to sampling design is the precision of the abundance index. Precision will depend on: 1) across-site variation in abundance within the habitat type that is sampled; 2) across-habitat type variation in abundance; and 3) site-to-site variation in detection probability. Examination of variation in trends in catch rates from existing data can provide only a very preliminary assessment of whether fewer or more sites are needed to achieve a target precision. It isn't clear how useful such an analysis would be without the data to account for across- and within-site variation in detection probability, and across-habitat type variation in abundance. For example, the assessment may show considerable variation in catch rates across beach seine sites in a region, suggesting that increasing the number of sites will lead to a large improvement in precision. However, much of the site-to-site variation in catch could be driven by variation in detection probability rather than by variation in actual densities. If that were the case, the best strategy to increase precision would be to obtain more detection probability estimates, rather than to sample more sites based on a single pass of effort. A similar issue arises with respect to sampling different habitat types. If the majority of the population is found in habitat x rather than y, clearly bigger gains in precision will be made by increasing sampling effort in type x. Thus, in the case of the beach seine data, a two-stage abundance estimation framework is required before a meaningful power analysis can be conducted to make informed decisions about changes to sampling to improve precision, or maintain precision at a lower cost.

Real-Time Monitoring

While it is clear that DJFMP staff have effectively implemented the monitoring required to make real-time management decisions intended to reduce mortality, the effectiveness of this program is less clear: whether and how consistently information was used, and whether an implemented action met the objectives; operational triggers for DCC appear to be a bit of a moving target between D-1641 and NMFS Biological Opinion. Thus, there is little evidence that the assumptions behind the management actions [flow diversion] have been rigorously evaluated and that real-time monitoring leads to effective management actions for fish protection. After nearly 15 years of real time management it should be possible to explicitly identify how, when, where and why management actions resulted and use that information to estimate benefits or lack of benefits.

Survival Studies

It is evident to the IEP-SAG that the DJSSS has made some real advances in measuring survival, although underlying mechanisms are still very uncertain other than directly observed losses on screens at the export facilities. Although the stated assumptions of dominant covariates that could explain survival rates appear reasonable, there is clear need for further evidence and to evaluate alternative covariates, e.g., flow isn't killing fish, but corresponds to redistribution to unknown predation sinks.

Within-site detection probability has been estimated by DJFMP for the Chipps Island trawl survey based on the release of CWTs upstream of the trawl locations. These studies have indicated that the detection probability is considerably less than the assumed values based on the volume of water sampled by the trawl. This result is not surprising as we know of few circumstances where it is reasonable to assume a uniform spatial distribution of fish. Additional quantification of trawl efficiency at Chipps Island and other locations is required, however such efforts will be significant. The CWT release method must make assumptions about the proportion of marks available for capture by the trawl, which depends on survival between the points of release and trawl locations, and the timing of emigration past the sampling area. Uncertainty in these 'closure' assumptions can lead to considerable variation in q_s estimates.

As discussed briefly during our deliberations, future efforts should use a combination of acoustic tag and CWT releases. The acoustic tagging experiments are producing intriguing, reach-specific estimates of survival that, overall, appear to support and refine earlier perceptions. The analysis and synthesis of salmon survival data has been stellar. These studies were well designed and used modern and comprehensive analytical methods. Application of acoustic tags allow direct estimation of survival to the trawl site and residency within the sampled area, while the CWT releases provide a sufficient sample to measure the detection probability with reasonable precision. Combined conventional (i.e., CWT) and telemetry-based tagging programs have been successfully used in other systems (e.g., Eberhardt 1990). They are more costly, but provide much more reliable estimates of abundance and detection probability when there are concerns about population closure.

The acoustic tag analyses are based on a multi-state mark-recapture Cormack-Jolly-Seber model that accounts for routing. These models jointly estimate survival, routing probabilities, and detection, and are well understood and the standard methods for analysis of this type of information. The write-up of the models and results is thorough and complete. Parameter estimates from these models are being incorporated in simulation models to refine future study design. Analysis of CWT survival studies has also been comprehensive. Use of hierarchical Bayesian models has provided an efficient and honest portrayal of survival estimates and their uncertainty. Considering the complexity of these models, the write-up and interpretation is relatively easy to follow. These modelling and analysis frameworks can and should be used to interpret data from future survival studies, and much of the analytic cost has already been covered. Thus, future analyses should be relatively inexpensive to produce and of high quality. Results from a variety of survival studies are being incorporated into management-focused simulation models where alternate actions can be evaluated (e.g., Delta Juvenile Fish Passage Model). Such integration will lead to even better focus for future survival studies.

However, the IEP-SAG notes several caveats. Given recent evidence the marine mammals can hear the 69 kHz tags, some caution is warranted when interpreting absolute survival estimates (Bowles et al. 2010, Rub et al. 2012). Additionally, to date, it appears that the studies have primarily focused on measuring the survival of juvenile salmonids and identifying correlates more than identifying mechanisms of mortality. The development of a conceptual model of the mortality agents within the Delta would help focus research efforts. Identification of physical variables, such as flow and temperature, the correlate with survival estimates are an important step. However, the incorporation of research components designed to identify mechanisms of mortality would be an important addition to on-going acoustic studies. For example, diet analysis, surveys, and/or related tagging studies of potential predators could be coupled with the tagging studies. As well, smaller juveniles (50-60 mm) are not yet tagged effectively and they comprise a portion of the naturally-produced fall Chinook that enter the Delta (Brandes & McLain 2001). Interpretation of acoustic tagging study results should take these issues into consideration.

4. ***Are the monitoring programs generating sufficient information to meet ESA compliance? Can the programs be used to assess ESA trends and abundance?***

The IEP-SAG appreciates that aspects of the DJFMP are focused on specific management needs. However, neither the needs nor the specific data streams are clearly identified, such that the program presently doesn't demonstrate effectiveness of its real-time (and other) monitoring for ESA compliance. Therefore, it is challenging for IEP-SAG to determine if the approaches are sufficient or effective. The program would benefit from a clear articulation of the specific management needs (real-time and long-term) and a presentation of their approach for Implementation Monitoring, Effectiveness Monitoring, and Targeted Studies (Atkinson et al. 2004). For example, the clearest real-time management example was for the determination of Sacramento Catch Index for use in the management of the Delta Cross Channel. However, based on the materials presented, it is not clear if the DJFMP data was used more than a few times in the last decade (Implementation Monitoring) or if the action is effective (Effectiveness Monitoring). Given a variety of management needs, a changing climate, and limited resources, the DJFMP needs to focus. Effective decisions regarding allocation of effort cannot be made without adequate information.

As presented for abundance and distribution, the basic trend information is valuable but is no longer sufficient, and the analyses of trends and correlations could go further. For example, Figure 17 in the background document is an intriguing example where techniques like quantile regression might be used to evaluate how the bins of data differ. Instead of saying it looks like there are differences but there is overlap in data, this seems to be one example that suggests that at flows less than 20,000 cfs there are factors secondary to flow or other than flow that have influences. Although curiosity and analysis alone will not take care of the other issues noted above which do limit what can be done with the trend data, integrating statistical calculation of probable past condition (highcast) estimates of accuracy and precision with further exploration of clear tendencies in data like this could benefit the program greatly.

There are three aspects to using the program for ESA compliance: real-time monitoring, long-term census data and special studies. It is curious that while assessing ability to evaluate ESA compliance was a direct question for the review panel and one of the most compelling justifications of the program overall, neither the background document nor the oral presentations addressed this explicitly. The panel remains uncertain about the usefulness of the real time monitoring component. It was not clear to what extent actions in this resource-consumptive activity were documented systematically; and there is a long-standing question about whether the program is addressing the long standing question of the effectiveness of real time monitoring in protecting populations and improving survival. Serious consideration of the effectiveness of real time monitoring and its cost-benefit compared to other activities should be part of a thorough re-design of the entire juvenile fish program. The "bang-for-the buck" of the census data sampling is also not clear. The background document highlights trend data and specific significant correlations with flows but opens questions of: (1) how widespread the correlations are; (2) why they occur in some places and not others; and, (3) where they suggest the involvement of factors other than the direct influence of flow.

There is no evidence that the program has considered a “no-holds-barred” redesign with the goal of maintaining the documentation of ESA trends and distribution while expanding into better integration of long-term monitoring, real-time monitoring and special studies. If the broad data set, with its significant and insignificant trends and relationships, were to be rigorously evaluated it might be possible to learn about ways to improve efficiencies in this program (creating resources for other program elements): Could sampling be consolidated spatially; Are there creative ways to reduce sampling intensity in time?; Could time and space be consolidated using models or relationships to fill in gaps? Such a ‘redesign evaluation’ could, as stated elsewhere, provide much better integration of special studies (e.g., genetics; hydroacoustic tagging) that would generate more mechanistic understanding of limiting factors on ESA species.

5. Do the programs generate information on other species useful for understanding ecosystem processes?

This question highlights some of the current program challenges. The objective of documenting the abundance and distribution of non-salmonid species within the program’s salmon-specific framework is too vague and needs critical evaluation. While there is obvious value in obtaining data and samples on Delta smelt and other key non-salmonids, the DJFMP and DJSSS should not be expected to meet the needs required to address their recovery. Differences in life history, ecology and population dynamics are only remotely overlapping with salmon. As acknowledged in the Background Document, it is not at all clear what the catches of the various non-salmonid species really mean given the diverse life histories and migratory nature of many of the species.

Most specifically, the objective to document the abundance and distribution of steelhead is likely unattainable goal for the program as currently designed because: (1) sampling methodology and design are inappropriate for steelhead; (2) in-stream traps likely offer the only reliable data (on entry to the Delta); and, (3) special studies (acoustic tagging) are the only other studies providing relatively unbiased results, but for specific questions. If presenting data on steelhead catch over time without estimates of efficiency or bias are considered important and useful, then the objective should be re-written to more accurately reflect that objective.

Furthermore, there is little clear information that the program is actually relating non-salmon species abundance and distribution to ecosystem processes *per se*. There are many ecosystem processes and, ideally, there would be a clear articulation of <u>which</u> and <u>why</u> ecosystem processes are the focus of the program or prioritized for management and conservation efforts. As noted above, the program is not currently generating robust estimates of distribution or abundance for other species, i.e., there are no estimates of accuracy, precision, or indication of representative sampling. In order to justify any expenditure on this activity, analyses of data (e.g., trends) should be compared to those found in other non-FWS programs. Most of the issues identified for estimating abundance and distribution of juvenile Chinook salmon, developed for Questions #2-3 above, apply to all species. Therefore, it should be evident that in order to achieve robust estimates of abundance and distribution for steelhead, Delta (*Hypomesus transpacificus*) and longfin smelt *(Spirinchus thaleichthys*), and other species, a substantial increase in effort and/or addition of sampling methodologies would be needed. In other words, it appears that the program is not adequately sampling to document the abundance and distribution of steelhead and non-salmonid species in the Delta (see Question #5).

As stated previously, the applicability of the program to non-salmon needs depends on its goals and objectives. We encourage the program to re-consider the goals if non-salmonids are to be a focus. A careful consideration of why the abundance and distribution of non-salmonids is of interest is needed to focus these efforts, if not completely revise that element in the program's goals and objectives. An essential short-term objective should be to determine if these by-catch data are useful as a complement or supplement to the primary data used to evaluate and manage non-salmonid species. That analysis could provide a basis for deciding if this objective is worth continuing entirely or in-part. Given all the other programs (many IEP special studies) that are specifically designed to address the non-salmonid, at-risk species, the real question is how this program interfaces with or complements those programs. Relationships and trends that explicitly compare outcomes from different program elements should be brought out and/or conducted. Ultimately, if the DJFMP/DJSSS is to have explicit responsibility for contributing critical information on non-salmon species, it needs to rigorously evaluate whether the program's study designs, techniques, and analyses are acquiring measurements that "produces reliable knowledge from experience instead of the slow, random accumulation gained from unexplained error" (Lee 1993).

6. Have the programs identified data limitations?

It was well-explained that the mesh size of the Chipps Island trawl changed due to efforts to minimize the catch of Delta smelt: it was originally 0.64 cm, was either 0.64 to 0.79 cm from 1997 to 2001, and 0.79 cm after 2001 (Dekar et al. 2013). It does not appear that there have been any estimates of the size bias associated with this change, i.e., less efficient collection of smaller juveniles, or quantitative assessment of the potential effects on abundance estimates, particularly for fall Chinook salmon emigrants. del Rosario *et al.* (2013) cited the relatively large size of winter-run Chinook salmon (53-188 mm) as a rationale for rejecting the likelihood of a bias in abundance estimates in their analysis. However, fall run Chinook can emigrate at smaller sizes (<50 mm) (Brandes and McLain 2001). Historical catch estimates of fall- and fall-run juvenile Chinook may need to account for this change.

The question of whether or not hatchery fish could serve as "surrogates" for naturally-produced fish in field studies was raised several times during the review. Although it is clear that there can be distinct migratory difference (Monzyk et al. 2009) between hatchery and natural fish, there are current research efforts to evaluate the potential of artificially rearing juvenile Chinook salmon that are phenotypically more similar to naturally-produced fish for use in field experiments, such as tagging studies. This research may be relevant to on-going and future DJFMP studies. Additional information can be found on-line:

http://www.dfw.state.or.us/fish/OHRC/docs/2012/Wild%20Spring%20Chinook%20Surrogate%20presentationORAFS-Final.pdf http://www.dfw.state.or.us/fish/OHRC/docs/2012/Dev_of_a_wild_fish_surrogate_Upper_Willamette_Chinook.pdf

7. ***Is data disseminated to users in readably useable formats and in sufficient time periods?***

8. ***Are the programs analyzing the data in a manner that produces accurate interpretation?***

The IEP-SAG's greatest concern with respect to salmonid data interpretation in the DJFMP relate to limitations in the interpretation of trend indices with respect to key management questions and data on other life stages (from other programs). Even if trends in salmonid catch rates in the Delta are corrected for the limitations identified above, they will not be very useful unless they are interpreted with respect to: 1) escapement; 2) fry and smolt outmigration estimates from screw traps; 3) returning adults (i.e., escapement + fishery catches; 4) environmental covariates (temperature, water quality, flow, exports, etc); and, 5) other biological parameters such as indices of food availability (zooplankton) and predation (e.g., striped bass creel data) in the Delta. Such integrated analyses will 'tell stories' that are relevant to management, and will identify key uncertainties that can be used to move the IEP forward (designing better studies and sampling programs). Such analyses may identify major inconsistencies between various monitoring metrics that will lead to improvements in the quality of trend indices.

The program has generated and, in some cases, described an immense amount of data over the years. Interpretations, curiosity, generalizations and objective, self-critical analyses are in much shorter supply. While the interpretations are accurate, based on the information available to the review panel, we suggest that this rich data set has not been fully exploited to obtain all the information it contains. The program should make further efforts to maximize access and dissemination of data, hiring others to address critical questions (or determine if such questions can be addressed) and encouraging in-house, self-critical interpretations. The modeling studies are a good example of one way to go about this, but there are others. An annual review could help accomplish this, partially contracted and partially in-house, with the goal of regularly and systematically thinking-through of what the data is saying.

The analysis and interpretation of catch trends for Chinook from the beach seine and trawl surveys has been very limited. To date, only basic trends over time and space have been presented. As discussed above, known biases have not been accounted for and variance estimates substantially underestimate the uncertainty in the trends. The causes for these limitations are clear, and the problem is unfortunately common to many large monitoring programs. DJFMP budgets are limited, and the staff is completely occupied with sampling, coordination, and basic reporting requirements. As a result, there is very limited budget and time for conducting more involved analyses. A recent analysis of delta smelt data (Grimaldo *et al.* submitted) indicates that the program is beginning to focus more on high quality analysis and synthesis, and such efforts need to be conducted on salmonid data.

There are encouraging signs of progress with respect to such synthetic analyses. Maunder and Deriso (2011) applied a stock assessment model to delta smelt that incorporated data from multiple surveys as well as indices of food availability, predation, and addressed some management issues. K. Newman is developing a more detailed version of this model which will likely provide additional insights. There are clear advantages here of having an in-house analyst with a good understanding of the system and the time and experience to carefully consider all the details of each data set and work closely with in-house staff. The OBAN model for winter-run Chinook holds promise as a quantitative and synthetic approach for one element of the salmon data. Considerable work on model parameterization and interpretation remains, and to date, the model has not provided new insights. However, discussions between the modelling team and DJFMP staff with regards to model data requirements are already leading to progress in monitoring (e.g., estimation of within-site detection probability for seine data).

Integrated analytical efforts should not be limited to modelers with abilities to conduct hierarchical Bayesian analysis and other advanced techniques. Often, very basic analyses can get to the same bottom lines of the 'story' that will be told by a complicated model, and often in a way that can be understood by a greater proportion of the interested audience. For example, simple time series plots of the Chipps Island trawl catch per effort and estimates of input of fry and smolts to the Delta from rotary screw traps, would provide insights about potential bottlenecks within the Delta, effects of physical conditions or abundance of food and predators, or problems with the trawl index .Ideally, senior DFJMP staff would devote time for such analyses and report on them frequently. Presentation of simple time series plots without interpretation and integration of other data sources as currently done should be viewed as a reporting failure. We empathize that DJFMP staff have responsibilities to provide data to the larger Bay Delta program, and this curtails such synthetic analytical efforts. However, as there appears to be limited coordinated analytical effort among major programs that focus on juvenile salmon, this critical work is falling through the cracks, and this severely limits the utility of the DJFMP data and improvements to future data collection efforts.

Based on the Background document, it appears that within-site detection probability for the Mossdale trawl survey involves multiple releases of CWTs each year. However, efficiency estimates appear to be calculated by dividing the total number of individuals recovered by the total number released on an annual basis. If data from each release were analyzed separately, estimates of intra-annual variation in efficiency could also be determined. Additionally, there may be the potential to quantify factors, such as flow, turbidity, etc., that influence efficiency.

9. *Are reports or peer-reviewed publications completed on frequent basis? What the measure for success?*

Publications are improved over past performances, but insightful, interpretive papers remain too few and too far between. The program needs to recognize that synthesis and publication of peer-reviewed products will not occur without targeted resources. We recommend that the preparation of synthesis products and publications be included as specific objectives of the DJFMP and that adequate resources are allocated to these important activities.

10. What recommendations can be made to improve the program?

Over-arching Program Approach

Not unlike previous SAG reviews of other IEP monitoring programs, the SAG believes that the DJFMP/DJSSS similarly needs to address three fundamental scientific inadequacies: (1) conduct a rigorous, statistically-based assessment of the basic monitoring study designs (specifically beach seine and trawl) to evaluate whether it is producing the expected level of precision, accuracy and completeness required for management decisions; (2) move beyond simple abundance and distribution to incorporate more life history information (e.g., more detailed analysis of length data, collection of mass on some portion of the collections, calculation of condition indices, and potentially some archival sample collection for otolith determination of growth, age, and, as noted earlier, hatchery vs. wild designation); and, (3) move from descriptive goals, objectives and study designs to address causal mechanisms that can help explain salmon survival and the underlying factors that account for it.

The program currently runs the risk of not being able to make defensible conclusions regarding the distribution and abundance of juvenile salmon in the Delta. Therefore, we strongly encourage the development of an approach (either internally or with the assistance of a contractor) to address the issues identified with the current beach seine data, i.e., lack of estimates of precision and bias, lack of adequate representation of available habitat, assumptions of fish distribution, inadequate accounting for hatchery and natural production, etc. Successful re-structuring of the sampling design to provide estimates of uncertainty and adequate representation of available habitat may require the addition, and potentially removal, of some sampling locations. Once such an approach is developed, synthesis of the existing data for broader distribution, such as a peer-reviewed publication, should be a high priority. Review of Honey *et al.* (2004) and Brown and Michniuk (2007) might provide some valuable insight into the non-representative nature of the program's beach seine study design.

Improving Integration of the Special Studies into the DJFMP/DJSSS Program

The relationship of the DJFMP/DJSSS program goals and objectives to the IEP special studies is also not clear although many of the latter provide interpretive power to the former. There are six explicit goals of the program but many related special studies; of ~160 special studies considered for funding in 2013[1], 42 (>26%) related directly to the DJFMP/DJSSS program. While some special studies (e.g., POD studies) seem to exemplify how special studies can inform and improve monitoring, we could not discern how these supplementary investigations are identified or prioritized within the context of the programmatic goals, and how they are integrated into the monitoring. Is it "top down" (identified by specific need, as part of a programmed process and schedule, and

[1] 10/23/2102; Summary and Costs of the 2013 Interagency Ecological Program Monitoring, Special Studies and Fish Facility Activities (Elements); DJFMP/DJSSS related projects identified by L. Grimaldo

targeted solicitation) or "bottom up" (unsolicited, ad hoc process, or open solicitation without targeted topics)? Given the potential of special studies to vastly augment DJFMP/DJSSS program goals and objectives, the IEP-SAG believes that it would be beneficial to institute more integration between special studies and monitoring. At the minimum, this could involve a clear process of identifying and setting priorities on knowledge gaps that can be used to focus special studies. Ultimately, selected special studies should be explicitly shifted into the monitoring program (e.g., POD and hydroacoustic tagging studies).

We recommend a more strategic, systematic and transparent approach to identifying, setting priorities and funding special studies. This would include clear articulation of the solicitation and selection process, and how it advances the DJFMP/DJSSS program goals and objectives. Additionally, the creation of a matrix or decision tree for identification of knowledge gaps and the prioritization of special studies is recommended.

Improving the Program but Maintaining Continuity with Historic Data

The DJFMP is well aware of many of the sampling design limitations described above, and documented many of their concerns in the pre-review document prepared for the SAG. Throughout our discussion, DJFMP staff expressed concern that changes to the existing program to address these issues could lead to a major discontinuity between historic and future trend data. There is certainly a legitimate and substantial concern which deserves consideration. This issue is not unique to the DJFMP. In many long term programs, initial efforts often yielded low precision and potential biased indices of abundance owing to limited funding, less experience in the system, non-random sampling, and use of gears that had lower efficiency compared to modern technology. In marine fisheries, where the fishery is often the sampling gear used for stock assessments, changes in technology and knowledge have had led to substantial changes in catchability over time. Modern stock assessment models commonly estimate catchability for various periods to reflect such changes. Such adjustments could readily be applied to DJFMP data to account for monitoring changes. With respect to this issue, we recommend the DJFMP move forward as follows:

a) Correct published indices of abundance trends over space and time given available information. This requires using best estimates of the hatchery contribution to the Chinook catch, and biases associated with LDC-based race designation. Revised estimates will require a formal model to account for these biases and will undoubtedly lead to greater uncertainty in reported trends.
b) Conduct major field efforts to quantify detection probability at across-habitat type and within-site scales. In some cases, these studies may provide coefficients that allow correction of past estimates. In other cases, they may simply provide a means of increasing the variance in past estimates to realistic levels. This may not be perceived as an improvement in the sense that that one is admitting we know less about the past than previously presented, but it is scientifically defensible.
c) Future estimates will be based on greater field effort that incorporates uncertainties discussed above. These values will be more precise or at least less biased. In some cases where locations or gears are changed, a dual-sampling period will be required

where both gear types are used concurrently, so that a calibration coefficient can be developed. For example, perhaps a future nearshore abundance estimation program includes both beach seining and boat electrofishing. Over time, the ratio of the population in these two habitat types can be determined. This ratio, and the year-to-year variation in it, can be used to back-calculate what the near shore index would have looked like had the electrofishing program been run prior to its initiation. Similarly, consideration might be given to trawl sampling below Chipps Island in the channel below Suisun Bay because such an alternate site may: (1) provide a more representative sample of what leaves the Delta as the entire section can be sampled (given an absence or low proportion of area that is too shallow to trawl); (2) have better acoustic properties and might reduce costs of losing/maintaining receivers; and, (3) potentially avoid smelt by-catch issue?

Uncertainty associated with the historic record may appear even greater with these changes, but will be less biased. This is certainly a better outcome than the presentation of a biased trend that has the appearance of high precision. Future modelling efforts (e.g., OBAN, Newman Delta Smelt) can easily incorporate changes in gear efficiency and precision in abundance estimates. In summary, moving forward with improved sampling approach in no way implies throwing the baby out with the bathwater. However, it very likely does imply getting a bigger bath or larger hot water heater. As with any renovation, having a solid plan that considers all steps of the renovation is a good idea before proceeding with the work.

Limitations on Learning about System Response

All the main objectives and goals listed in the DJFMP SAG review document can technically be labelled ‘means’ objectives. Monitoring trends in abundance, distribution, and even survival over space and time, are simply a means of getting to the larger objective of understanding how natural and anthropogenically-determined flow patterns and other factors influence the survival and health of fish moving through and residing in the Delta. Once this overarching objective is acknowledged, a broader view of what determines learning about system response is required. This view can be summarized in the equation,

$$I = E + O,$$

where I denotes the amount of information gained about system response, E represents the contribution to learning from experimentation, and O determines the contribution from observation. As an example, if a student wishes to understand the effectiveness of an antibiotic to suppress bacterial growth, they need a way of accurately measuring growth (good laboratory technique) and they need to expose bacteria to different levels of the treatment. That is, learning (I) depends on accurate and precise observation (0) as well as an informative experimental design (E) which consists of contrasting treatments and adequate replication. This entire review, with the exception of limited discussion about outcomes from the VAMP studies, has focused solely on the observation element of the equation above. It won’t be possible to increase ‘I’ and make progress to the larger objective of learning, without significant consideration of the experimental component of the equation.

Decisions on experimental elements of the larger Bay-Delta program are arguably well beyond the scope of the DJFMP. Even if this is the case, results from DFJMP can and should be a major contributor to discussions about experimental design. Key findings from DFJMP studies need to be used to identify experiments that would help resolve major uncertainties. Senior DFJMP staff need to make sure these messages are highlighted and heard. Recent results from acoustic-tag based juvenile survival studies provide an illustrative example. Predation within the lower San Joaquin River, primarily by striped bass and largemouth bass, has been hypothesized to be a significant factor reducing the survival of juvenile Chinook salmon (SJRGA 2013). A very interesting and key finding is the very low survival rates through the central and southern Delta, and in particular, indications of low survival in Clifton Court forebay and other inflows to CVP and SWP facilities. The biggest uncertainty in the survival studies is on the details about predation losses. First, at the observation level there is some uncertainty about the designation of whether a tagged salmonid has been consumed by a predator. At a broader level, there is uncertainty about the fraction of tag mortality caused by predation, who the major predators are, and what factors effect rates of piscivory (turbidity, flow, depth, etc.).

Additional study, and in particular, experimentation, is required to get to the bottom of these uncertainties, and the results can be used to provide the details on what such experimentation should look like. Acoustic tag survival studies suggest, perhaps strongly, that entrainment mortality should be viewed more broadly. It isn't limited to losses due to impingements at the pumps, but occurs upstream as fish are routed through predator filled areas due to routing flow to the pumps. A predator removal experiment, such as the proposed test to use CO_2 as an aid to remove predators from the TFCF bypass system, would provide major opportunities to resolve key uncertainties regarding this hypothesis. Survival rates of tagged fish entering the forebay in years with and without predator removal would directly quantify the predation effect. The incidence of piscivory in predators that are removed can be quantified, and such sampling will also help resolve uncertainties about how to classify whether a tagged salmonid is consumed or not. Predator removal experiments have been an important element in other major restoration efforts within the US, such as in the Columbia and Colorado Rivers (e.g., Coggins *et al.* 2011, Yard *et al.* 2011). Given the strong evidence of significant non-native predation in the Delta, it's surprising there is little discussion of predator control in the Bay Delta system.

Decisions on conducting real-world experiments are made by policy makers. Scientists have the responsibility of identifying key uncertainties and providing advice on the experiments required to resolve them. Policy makers tweak, modify, or deny such experiments based on the values of the stakeholders they represent. Experiments which result in severe downsides for key stakeholders are unlikely to happen, at least not until there is solid supporting evidence that suggests these experiments will result in desired outcomes. These factors result in decision-makers typically taking 'baby-steps' towards acceptance of more informative but riskier or costly experimentation. Smaller scale manipulations, sometimes termed 'mini-experiments' are appealing because they minimize the down-side of experimentation and costs while still providing opportunities for learning. We would argue that a removal experiment in an area like Clifton Court forebay is a good example of a useful mini-experiment because it's hard to identify many downsides but there are lots of upsides. Agencies tasked with improving the status of endangered species would presumably support an experimental action that could reduce mortality. Water users should be interested in an experimental management action that has the potential to reduce loss of ESA-listed species that may minimize impacts on water delivery. Fisherman that target non-native species such as striped bass and largemouth bass would be largely unaffected as the experiment would only affect a small part of the larger fishing area. They would likely have concerns about whether a successful outcome from such an experiment would lead to a larger-scale removal effort, and this may result in pressure on managers to avoid even a small-scale experiment. Scientists within DJFMP can contribute to this discussion by highlighting key aspects of their results with respect to policy decisions in an objective way. They need to clearly articulate the potential learning and resource benefits of this type of experiment, and provide advice on the design that minimizes downsides while still providing an informative situation. Focus on the policy-relevant component of results, or 'telling the story', provides the support decision makers need to make informative experiments happen.

Suggestions for Revision of Background Document

The background document describes the sampling approach and the programmatic niche that this program fits, including praise of it in some publications and review presentations. But, an explicit comparison with other sources of data would be valuable (e.g., how are trends or distribution similar; how do they differ), keeping in mind the sampling and equipment limitations is one way to begin to address this. The team should evaluate whether other measures of populations for which data is available (e.g., juvenile production index) should be included to help understand factors influencing survival overall. This may require collaboration with other IEP agencies.

A more detailed and informative map is needed. For example, many of the referenced landmarks discussed, such as Yolo Bypass. The Delta Cross Channel, Jersey Point, and Georgiana Slough, are not identified on the map.

We suggest including a table that outlines the management applications of specific data products. Given the presentation and discussion at the review, this may be an initial draft that could be refined over time as the program evaluation and re-focusing continues.

The SAG received several "batches" of related references for review. Given the longevity and scope of the DJFMP, the maintenance of an annotated bibliography would be beneficial for numerous applications, such as distribution to an external review team. We strongly encourage the initiation and maintenance of an annotated bibliography of literature that incorporates data generated by the DJFMP.

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Appendix A

IEP-SAG Review Panel: IEP Delta Juvenile Fishes Monitoring Program and Delta Juvenile Salmonid Survival Studies

4-5 June 2013, Sacramento, CA

Stephen Monismith - Permanent SAG member; Chair
Professor; Director of the Environmental Fluid Mechanics Laboratory
Department of Civil and Environmental Engineering
Stanford University

Charles "Si" Simenstad - Permanent SAG member; temporary Chair for thisreview
Research Professor
School of Aquatic and Fishery Sciences
University of Washington

Samuel N. Luoma – Permanent SAG member
Research Ecologist
John Muir Institute of the Environment
University of California-Davis
&
Emeritus Senior Scientist
US Geological Survey

Josh Korman- 2013 Special SAG member
Adjunct Professor
University of British Columbia
Principal; Ecometric Research

Jessica Miller - 2013 Special SAG member
Associate Professor; Fisheries and Wildlife
Coastal Oregon Marine Experiment Station (COMES)
Hatfield Marine Science Center
Oregon State University

Brief biographies of the Review Panel members are available at: http://www.water.ca.gov/iep/activities/sag.cfm

Appendix B

IEP Review Panel meeting agenda:

Interagency Ecological Program Scientific Advisory Group Review of the Delta Juvenile Fishes Monitoring Program

980 9th Street, 2nd floor Conference Room

Sacramento, California

June 4-5, 2013

June 4th

1030	Welcome and Science Advisory Group Introduction (Anke Mueller-Solger, DSC)
1040	Review Introduction: Review Goals, Objectives and Previous Reviews (Lenny Grimaldo, USBR)
1050	Summary of Background Report by Program Objective
1050 – 1120	Long-term, spring-time salmon monitoring (Pat Brandes, FWS)
1120 – 1150	Year-round monitoring of all salmon races (Matt Dekar, FWS)
1150 – 1220	Monitoring to inform real-time management of salmonids (Jonathan Speegle, FWS)
1220 – 1320	Lunch break *(Lunch not provided)*
1320 – 1350	What does the program tell us about steelhead? (Matt Dekar, FWS)
1350 – 1420	Non-salmonid monitoring, including Liberty Island (Joseph Kirsch & Lori Smith, FWS)
1420 – 1450	Salmonid survival studies (Pat Brandes, FWS)
1450 – 1505	Summary of recommendations in background report (Matt Dekar, FWS)
1505 – 1520	Break
1520 – 1530	Overview of past DJFMP use, recent examples of how data is being used for modeling and management and what is needed in the future (Lenny Grimaldo, USBR)
1530 – 1550	How is DJFMP data and information used in salmonid management? (Jeff McLain, NMFS)
1550 – 1610	NMFS Life Cycle model (Steve Lindley, NMFS)
1610	End-user feedback
1610 – 1630	OBAN model (Noble Hendrix, QEDA Consulting)
1630 – 1650	DFP and IOS model (Brad Cavallo, Cramer Fish Science)
1650 – 1720	Questions and comments from the audience, wrap-up (Anke Mueller-Solger, DSC)

June 5th

0900 – 1200	**PRIVATE** SAG Deliberation (USBR/USFWS staff will be available if needed)
1400 – 1550	Presentation and Discussion of Initial SAG Review Findings
1550 – 1600	Next Steps, Concluding Remarks, and Adjourn (All)