DEPARTMENT OF THE INTERIOR/DEPARTMENT OF COMMERCE TASK FORCE
DRAFT INTEGRATED BAY DELTA CONSERVATION PLAN BIOLOGICAL OPINION STRATEGY
JUNE 9, 2010

On May 3, 2010, the Secretaries of the Interior and Commerce issued a letter to their fellow members of the Federal Bay-Delta Leadership Committee, committing to a joint Department of the Interior (DOI) and Department of Commerce (DOC) initiative to develop a single integrated Biological Opinion (BiOp) that would address the Bay Delta Conservation Plan (BDCP) and related operations of the Federal Central Valley Project (CVP) and California's State Water Project (SWP). The letter created a DOI/DOC Task Force that would develop and implement a Near-Term Science Strategy and an Integrated BDCP BiOp Strategy. The Task Force was formed in May 2010 with staff from the Bureau of Reclamation (Reclamation), U.S. Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS) and U.S. Geological Survey (USGS).

Two documents have been prepared in response to the Secretaries' letter: the "Near-Term Science Strategy" and the "Integrated BDCP BiOp Strategy". The first document identifies an initial list of near-term scientific research issues arising from the National Academy of Sciences report entitled, "A Scientific Assessment of Alternatives for Reducing Water Management Effects on Threatened and Endangered Fishes in California's Bay Delta" (NAS Report). The second document identifies analytical methods and modeling tools, responsibilities, integration of independent peer review, and critical science gaps that need to be addressed to successfully complete an integrated BDCP BiOp. While these documents address different aspects of the science challenge the Federal agencies face, they are not independent of one another.

The documents are initial steps in the creation of an integrated science strategy to address the needs articulated by the NAS Report and the need for a sound scientific foundation for the BDCP. It is important to emphasize that the science strategy outlined in these documents is preliminary and subject to revision on an ongoing basis. While a timeline is given for each element, there are interdependencies among elements, and no attempt has been made to establish internal priorities other than by expected completion date. Consequently, additional work is intended to develop priorities, study sequencing, coordination, and other details needed to ensure efficient implementation and the best outcome. These efforts will require a careful review of related scientific activities occurring outside the Federal agencies and the BDCP cooperating entities, and independent scientific expert review of the science strategy itself.

As set forth in the Secretaries' May 3, 2010 letter, this draft document will be made available to independent scientific experts for review and comment and will be refined in light of comment from these experts and others. This will help ensure that the integrated strategy complements and is coordinated with related scientific actions undertaken by other entities and that it encourages other entities to undertake scientific actions that support and enhance the integrated BDCP BiOp strategy. As the plan is refined, a funding plan to undertake elements that are not already funded will be developed.

This initial draft of the Integrated BiOp Strategy outlines the steps and timing required to complete the biological opinions associated with the BDCP as well as ongoing CVP operations. The strategy and timeline will be monitored and may be adjusted as the BDCP moves forward and as the strategy is implemented. The BDCP is being developed with stakeholder participation by the California Department of Water Resources (DWR), in partnership with Reclamation, and federal and state water contractors to address long-term environmental needs of delta native species and to improve water supply reliability. The BDCP will address water conveyance and project operations and will likely include the construction of new north Delta conveyance facilities. The BDCP will also include measures to restore Delta habitat and will describe the effects of and potential measures to reduce threats such as pollution and introduced species. It is anticipated that the BDCP will result in a 50-year term incidental take permit under ESA Section 10.

As part of the HCP process, FWS and NMFS are required under section 7 of the ESA to consult on their potential permit issuance. At the same time, Reclamation plans to re-initiate Section 7 consultation on CVP project operations as the result of new integrated CVP-SWP water project operations that will result from the BDCP. The result will be the integrated biological opinion that is described in the Secretaries' May 3 letter. It is intended that the framework for implementing this strategy will be created in the next few months and that implementation of the strategy will begin in November 2010, when a draft of the BDCP is scheduled to be complete.

The Integrated BDCP BiOp Strategy includes analytical methods and modeling tools, critical gaps requiring development of additional tools, peer review, and a general approach to preparing, reviewing, and approving documents. The Strategy will be implemented by a number of Federal agencies: Reclamation, FWS, NMFS, and perhaps the U.S. Army Corps of Engineers (USACE) will be action agencies initiating consultation; FWS and NMFS will be completing section 7 consultation on the BDCP and CVP actions; and USGS will be providing technical assistance with the analysis.

Integration with the BDCP Planning process will be a key element to successful completion of this strategy. Reclamation, FWS and NMFS are working with the BDCP agencies and consultants to complete a BDCP Effects Analysis that can serve as the foundation of this strategy as well as an element of the BDCP EIS/EIR. As part of this integration, we anticipate working closely with DWR and the California Department of Fish and Game (CDFG) to ensure we use their expertise and address any concerns they have during the consultation process.

Integrated BiOp Strategy Teams

Completion of the Integrated BDCP BiOp will involve a number of processes: agreement upon the project description, assessment of effects upon covered and listed species, preparation of a biological assessment and a biological opinion, and agency review and approval of the final BiOp. The strategy will need to look at ways to streamline efforts and prioritize activities. Each step is not discrete, and some tasks will overlap, allowing for sharing of interagency resources. For that reason, one of the first steps will be staffing a number of interagency teams. However, to ensure coordination amongst the teams and successful completion of key milestones and tasks,

leadership BiOp Team Lead will be designated as soon as possible. The following is a list of teams that would work under the direction of the BiOp Team Lead:

- Managers Team – A group of managers from Reclamation, FWS and NMFS will make decisions on priorities, staffing, policy issues, and any need for issue elevation. This team will also coordinate peer reviews, funding, and communications.

- Modeling Team – A group of hydrologists, biologist and statisticians from Reclamation, FWS, NMFS and USGS will oversee or conduct modeling for hydrology, hydrodynamics, ecosystem processes, and population dynamics.

- Biological Team - A group of technical specialists from Reclamation, FWS, NMFS and USGS will utilize the work from the Modeling Team to assess effects of the proposed project upon listed and covered species. This group will work closely with the BDCP Effects Analysis Team and use their work as the foundation of their assessments, as appropriate.

- BA Drafting Team – A team of project managers, biologists and regulatory specialists will assist Reclamation in preparing the biological assessment (BA). Reclamation will lead this team with participation of staff from FWS and NMFS. This interagency effort will help ensure that the BA meets the needs of the BiOp Drafting Team and minimize the need for reviews and requests for additional information.

- BiOp Drafting Team - A team of biologists and regulatory specialists will provide assistance to FWS and NMFS in drafting the BiOp. FWS and NMFS will lead this team and Reclamation staff will assist with drafting and expedited requests for additional information (as necessary).

- Review Team - A team of biologists and regulatory specialists from Reclamation, FWS and NMFS will review the draft BA and BiOp. This team will be comprised of agency staff that were not involved in the preparation of the documents, including staff from outside the region.

- Attorneys Team – A team of attorneys representing Reclamation, FWS and NMFS will counsel the Managers Team on policy issues and legal adequacy of work products.

Integrated BiOp Process

The following is a list of key steps or milestones in the Integrated BiOp process. These activities are listed in their approximate order of priority, realizing that some actions could occur simultaneously. The earlier actions are given priority for two reasons: they are required for completion of later actions or they are steps that can be completed ahead of later more challenging work, thus allowing for an overall time savings for the entire process.

- USACE and Environmental Protection Agency (EPA) Involvement – The Management Team will work with the USACE and EPA to determine what role they will have in the Integrated BiOp Process and identify USACE and EPA staff to participate on the various teams.

- Lessons Learned – As soon as possible after determining USACE and EPA involvement, Management and Attorneys Teams will examine examples of other FWS-NMFS BiOps (completed or attempted) to identify processes that have worked and to proactively identify solutions to potential issues that could arise.

- Timeline – The Management Team will develop a detailed outline that will be used to manage the overall Integrated BiOp Process. This timeline will be tiered from the BDCP timeline that indicates completion of a draft plan in November 2010.

- Elevation Process – The Management Team, assisted by the Attorneys Team, will establish an elevation process so that any potential conflicts or issues can be resolved quickly. If appropriate, the Management Team will consider other established FWS-NMFS elevation processes that can serve as models or be adopted for this strategy.

- Project Description – Because of the complexity and scope of the BDCP, a full understanding of the project description will be necessary to structure the BA and BiOp, making this a critical early step in the process. The Management Team and BA Drafting Team will prepare a project description that incorporates the BDCP actions with the ongoing operations of CVP and SWP. The Project Description will be prepared with placeholders for those components that are still in development. The Attorneys Team will assist with preparation and review of the project description. The Federal Action Agencies will commit to final agreement on the project description, in coordination with DWR and CDFG.

- Effects Methodology – An interagency and stakeholder team participating in the BDCP has developed the "Methods for the BDCP Effects Analysis" that outlines various hydrological, hydrodynamic, water quality, and biological assessment tools that will be used to determine effects of the BDCP actions upon covered species. The Modeling Team will use these tools, along with others designed to assess upstream actions, to determine the effects of the entire BDCP-CVP suite of actions. In addition, a number of data gaps have been identified along with strategies to fill those gaps and provide additional tools and information for the Integrated BiOp effects analysis. A complete discussion of the modeling tools, data gaps and strategies to fill gaps can be found in Attachment 1.

- Independent Science Review - The table below outlines an approach and schedule for conducting independent science reviews of specific products to be developed in the BDCP process. This approach incorporates reviews by at least three separate groups, including a panel to be selected by the Delta Science Program (DSP), the National Research Council's (NRC) Committee on Sustainable Water and Environmental

Management in the California Bay-Delta, and the Delta Stewardship Council's (DSC) Independent Science Board. The schedule for the reviews is based on estimates of when the documents for review will be available, and to allow a reasonable time for review following product availability and a sufficient time to incorporate comments prior to finalizing the product. Because each of the products will include and build on information from prior products, reviews of prior products will likely also be addressed as the subsequent products are developed. This table does not include the NRC Committee's second report, scheduled to be available in mid-November 2011. Relevant new information in that report will be considered as the BDCP and associated EIS/EIR and Biological Opinion are finalized and a Record of Decision/Notice of Determination reached.

Table 1. Summary of BDCP Independent Science Review Strategy

Product to be reviewed	**Product potentially available**	**Purpose of review**	**Reviewer(s), review product**	**Review potentially available**
Effects analysis for BDCP, including methodology	Mid-to-late July 2010	Assess adequacy of analyses and support for effects of BDCP, including adequacy of analytical tools and methods	Panel selected by the DSP, report	September 2010
November 2010 draft BDCP	November 2010	Assess adequacy of the use of science and adaptive management in the BDCP	NRC Committee, letter report	April 2011
BDCP Draft EIS/R	February 2011	Assess adequacy of analyses, support for effects of all alternatives and resources	DSC's Independent Science Board, report	May 2011
BDCP and related water operations Draft BA	April 2011	Assess adequacy of analyses, support for assessment of BDCP and related water operations	DSC's Independent Science Board, report	July 2011
BDCP and related water operations Draft BO	November 2011	Assess adequacy of analyses, support for assessment of biological effects of BDCP and related water operations	DSC's Independent Science Board, report	February 2012

- Effects Analysis – The Modeling and Biological Teams will conduct the Effects Analysis using the Effects Methodology prepared in the steps above. It is anticipated that the BDCP effects analysis will be the foundation for the BA and BiOp effects analysis, as appropriate. Members of the Modeling and Biological teams will work with the BDCP participants and consultants to provide technical advice to ensure that the BDCP effects analysis can serve as the foundation for similar analyses in the EIS/EIR, BA, and integrated BiOp.

- Effects Analysis Independent Review – As described in Table 1.

- BA and BiOp Outlines – The BA and BiOp Drafting Teams will each develop outlines for the BA and BiOp documents. The teams will base the outlines on Section 7 guidelines and the format used to describe the Project Description. The Management and Attorneys Teams will review and approve the document outlines.

- Species Accounts and Baselines – Because these two sections can be completed before the Project Description is finalized and the Effects Analysis is complete, the BO Drafting

team will prepare information about the species covered by BDCP (see Attachment 2 for list) and the southern resident population of killer whales, including baseline conditions.

- BA Preparation – Once the Effects Analysis and independent Science Review described above is complete, the BA team will use that information, along with the completed Project Description, to prepare a Draft BA for review.

- BA Review and Revision - The Review Team will review the draft BA, with assistance from the Managers and Attorneys Teams. The BA Drafting Team will make revisions to the draft BA based on comments from the reviewers. The BA Drafting and Review Teams will work closely together to streamline this process.

- BA Independent Review - As described in Table 1.

- Initiation of Consultation – Upon agreement on the content of the BA, Reclamation will submit the document to FWS and NMFS for consultation.

- BiOp Preparation – Utilizing the BA, the Effects Analysis, Species Accounts and Baselines prepared in the steps above, the BiOp Drafting Team will prepare a draft BiOp.

- BiOp Review - The Review Team will review the draft BiOp, with assistance from the Managers and Attorneys Teams. The BiOp Drafting Team will make revisions to the draft BiOp based on comments from the reviewers. The BiOp Drafting and Review Teams will work closely together to streamline this process.
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- BiOp Independent Review - As described in Table 1.

- BiOp Approval – FWS and NMFS will approve and issue the BiOp.

The process outlined above will be challenging to complete given the complexity of the project to be analyzed, the short timeline, and potential differences in agencies policies and delegations of authority. A number of potential issues may need discussion by the Management and Attorneys Teams and may require elevation to the Task Force.

ATTACHMENT 1

ANALYTICAL METHODS AND MODELING TOOLS

Analytical methods and modeling tools for the BDCP are currently being developed by a team of interagency staff, other BDCP participants, and BDCP consultants. The process will result in completion of a *Methods for the BDCP Effect Analysis* (Methods) document that the FWS, NMFS and Reclamation expect to use to guide the effects analysis for the BA and BiOp, as well as the EIS/R documents for BDCP. The Method document is expected to be completed in the next few weeks and it will be supplemented as the analyses proceed.

The Methods document will be used to complete physical modeling, including the parameters of hydrology, hydrodynamics and water quality. These results will be used to inform the appropriate follow-on environmental modeling and evaluations identified in the Methods document to complete the analysis. If additional analytical modeling and methods are necessary, FWS, NMFS and Reclamation will identify the additional methodology as early as possible. Focused effort will seek to recognize and fill critical gaps in our scientific knowledge and apply appropriate review and revision.

FWS, NMFS and Reclamation will review and make recommendations regarding revision of assumptions and evaluations in the physical and environmental analyses provided in the Methods document. Independent peer reviews of specific products will be conducted during the BDCP process, including the Methods document identified above. Each of these reviews will commence as drafts of products became available, while issues and problems raised in reviews of prior products will be addressed as the subsequent products are developed. A more-detailed description of the review process is in Table 1 in the Integrated BiOp Strategy.

ANALYTICAL TOOLS AND METHODOLOGY CRITICAL GAPS

The Task Force recognizes that critical gaps remain in our scientific knowledge of the Bay-Delta system. These include a number of unresolved scientific issues identified during the most recent consultations, as well as issues raised by the NAS Report. To meet the analytical needs of the integrated BDCP BiOp process, we have developed an initial list of activities that will help fill some of these gaps and improve our ability to assess the impacts of BDCP and CVP actions. Recognizing the inherent time lag between initiating an ecological, biological or physical study, and applying the results of those studies to management, we identify multiple lines of inquiry that must begin immediately so that results from these studies can be used in a timely manner to guide better management of the system. Some of these studies will take several years to complete, and therefore are not likely to contribute directly to the creation of the integrated BiOp. However, the results from these studies (and others that will inevitably follow) are expected to provide information that will contribute to the subsequent implementation of the BiOp and adaptive management of the system into the future. Some of these activities work together, such that data collected in one effort will help inform model creation or verification in another. This list is not meant to be a comprehensive list of all research occurring in the Delta,

as a number of other research efforts are on-going, such as the work on Central Valley salmonids being done by NMFS Southwest Fisheries Science Center.

The following activities have been identified as providing additional tools and information for completion of the BiOp and implementation of the BDCP, and are listed in order of priority:

1. Life Cycle Models

The NAS Report recommended that completion of life cycle models be given a high priority. Appropriate species life cycle models will assist in understanding life-cycle dynamics and assessing the effects of proposed BDCP and CVP actions on covered species.

The following models are under development and are expected to be available for use in the BiOp process:

Planning Level Delta Smelt Life Cycle Model. DOI agency staff scientists have initiated efforts to develop a planning level life cycle model for delta smelt that uses the CALSIM II and DSM2 outputs described above and recent species-specific information in a life-cycle context. This will create a simple model intended to allow a more explicit comparison of the effects of project alternatives to natural sources of mortality and their interactions.

Timeline: The model development is anticipated to begin during summer 2010 and take approximately three months.

Hierarchical Time Series Delta Smelt Life Cycle Model. A second quantitative life history model for delta smelt is currently under development. This model is a hierarchical time series model with at least two levels, a state process model and an observation model, which are fit to existing data using statistical methods. The state process model will be used to predict abundances of delta smelt at different life history stages (e.g., spawning adults, post-larval stage fish, juveniles, and pre-spawning adults) and in two or more regions including the western Delta, north and eastern Delta, and southern Delta. The observational model is intended to link data collected from multiple aquatic species surveys (at least the Spring Kodiak trawl survey, the Fall Midwater trawl survey, the 20 mm survey, and the Summer Townet survey) to the corresponding unobserved abundances by life stage. These quantitative tools will allow us to model population dynamics of these fish, to quantify the effects of different factors on dynamics, and to predict the effects of management actions. The work is being led by Dr. Ken Newman of the FWS and involves scientists from the recent IEP-National Center for Ecological Analysis and Synthesis collaboration.

Timeline: A testable model is anticipated to be available by the end of 2010, with additional work to further develop and refine the model continuing in to the following year.

Salmonid Shiraz model. Shiraz is a multistage Beverton–Holt model that describes the production of salmon from one life stage to the next by incorporating detailed information on metrics such as density-dependent population growth, habitat attributes, hatchery operations, and

harvest management (Scheuerell et al 2006, Scheuerell and Hilborn 2009). NMFS Southwest Science center is working to adapt the Shiraz model to Central Valley and Delta salmonids for the purposes of evaluating various operational and restoration scenarios (see Near-Term Science Strategy). By modeling physical and biological attributes, such as water temperature, flow, and habitat and the biological attributes of fish populations over time, the expected changes in fish abundance can be estimated. Shiraz is a detailed life history model that is ideal for estimating the affects of environmental changes on life stages and populations of salmon.

Timeline: The preliminary model results will be completed by May of 2011, and the final model results will be completed by May of 2012.

2. Model Accuracy

The Delta is a complex and diverse ecosystem. Accuracy of any associated analytical process will be limited to the extent of our existing knowledge and technology. New information would modify that knowledge base as it becomes available through the efforts as recommended below.

The NAS Report made multiple recommendations for improving model accuracy and model use. The following tasks identify data needs to improve model accuracy.

3-Dimensional data Sets for Model Validation and Application. It is recognized within the Bay-Delta scientific/modeling community that development and use of multi-dimensional models (UnTRIM; SUNTANS; RMA11) for accurate characterization of Delta hydrodynamics and estuarine aquatic processes is essential to effective management and planning (CALFED Science Program, 2008 2009). Such development and use is ongoing, but to date, little resource or institutional input has been made to provide adequate "real-world" data with which to test, evaluate, and calibrate such models. Model developers currently must rely on limited available environmental data collected mostly for other purposes for testing and tuning their 2- and 3-dimensional models and associated outputs. An agency-funded mandate to collect, store, and distribute such a 3-dimensional "calibration" dataset is vital to the effective eventual use of the more sophisticated and powerful 3-D models under development and modification with the Estuary science community. In order to test and calibrate 3-D models, a test set of 3-D data will need to be collected, stored, and analyzed. This task will address this need.

Collection of a field tracer-oriented data set, using a conservative tracer such as sulfur hexafluoride (SF_6), will be used for the explicit purpose of validation and testing of 3-D hydrodynamic transport and fate models. This will be the only way to evaluate the accuracy of these models. The need for such a data set has been articulated repeatedly in such forums as the California Water and Environmental Water Forum, the Interagency Ecological Program Scientific Advisory Group, and the University of California/Davis Watershed Sciences Center.

The following questions would be answered by completing this task: 1) how accurate are the 3-D models for depicting transport and fate of water quality constituents like ammonium or larval fish; 2) what data standards are important to the integrity of 3-D model output and post-

processing storage needs; and 3) what standard methods will we use for development, comparison, testing, and "qualification" of multi-dimensional models?

Timeline: If this effort is begun next year, the data should start becoming available to Delta modelers in year 2.

3. Salvage Mortality

Current salvage monitoring provides estimates of the salvage of fish at the export facilities. Salvage has generally been thought to be proportionate to actual entrainment, but our ability to extrapolate from salvage to actual entrainment is limited by data gaps in prescreen mortality, variability in screening efficiency, and other factors. Current entrainment estimates are based on historical studies. New monitoring would allow for improved entrainment loss evaluations considering current operations, species trends, and environmental parameters.

This study is not underway at this time but could be within a few months. It would take immediate funding and staffing to initiate the study in a manner that would allow the results to inform the BDCP process.

Monitoring of Larval, Juvenile and Adult Delta Smelt at CVP and SWP Facilities. Independent scientific reviews have recommended evaluation of entrainment losses, particularly in Clifton Court Forebay (e.g. EWA Review Panel 2002; SAG review - IEP Delta Smelt Program; Independent Expert Panel Review FFA-IQA Correction Requests 2009). While entrainment of delta smelt into SWP and CVP facilities has been assumed to be a constant proportion of the corresponding salvage at fish facilities, new information from an earlier CALFED pilot project suggests that the real relationship may be more complicated. This action would enable more precise measurement of delta smelt entrainment and pre-entrainment losses.

This extended effort would provide additional species information as soon as year-2. In year-1 there would be laboratory and field testing to design entrainment monitoring and begin culturing delta smelt needed for experiments. In years 1 through 4, mark-recapture experiments would be conducted at the SWP and CVP facilities to observe the relationship between salvage, fish facility efficiency, pre-screen losses and other variables

Timeline: Early results will be obtained as soon as year 2, with additional findings in years 3 and beyond.

4. Delta Contaminants

Contaminants have been identified as one of the many stressors impacting Delta endemic aquatic and terrestrial species. Contaminants like ammonia/ammonium and copper can impact the Delta foodweb and its energy balance, while other numerous contaminants can impact various life stages and processes like reproduction, predator avoidance, inter- and intra-species competition, and mortality.

The methyl-mercury studies below have been proposed and their evaluation is underway. The smelt contaminant study would take funding and staffing to initiate and complete portions in a manner that would inform the BiOp.

Methyl Mercury. Several evaluations have been proposed that should be able to inform the BDCP BiOp process about effects of methyl-mercury in Delta wetland and floodplain habitats over the next 1-2 years. These include a Sacramento River Watershed Program 319 project proposal entitled "*Planning for Delta Methylmercury TMDL Implementation for Wetlands and Irrigated Agriculture*" which will evaluate methodologies for compliance for the Delta Mercury Control Program, and a BLM 319 grant proposal entitled "*Wetland Management and Agricultural Organic Matter Reduction to Decrease Methylmercury Loads from the Cosumnes River Preserve*" which seeks to reduce methylmercury discharge loads from the Cosumnes River Preserve's managed wetland units and organic rice operations.

Timeline: These studies will start this year and useful information is expected in year 2.

Methylmercury Processes in Delta Wetlands. Wetlands are well known to generally have the kind of environmental conditions (biogeochemistry) that tend to promote the formation of methylmercury. Of particular interest is the observation that methylmercury concentrations in water and fish are not elevated in the Sacramento-San Joaquin Delta, but are in other similar environments. These studies will aim to unravel this mystery through examining the critical biogeochemical processes that contribute to the formation and degradation of methylmercury in Delta wetland environments. This is of particular concern because BDCP is proposing restoration of tens of thousands of land in the Delta to wetlands.

Timeline: These studies will start as soon as possible (currently unfunded) and should have significant information and knowledge in year 2, and additional findings in year 3 and beyond.

Delta Smelt Contaminants. There have been long-standing concerns about the synergistic effects of multiple contaminants in the Delta's waterways and what the effects of those synergies might be for listed fishes including delta smelt (Luoma et al. 2008). There is no question that delta smelt are exposed to contaminants; their reproduction coincides with stormwater inputs that mobilize pesticides (Kuivila and Moon 2004) and the livers of some individuals show histopathologic evidence of exposure (Bennett 2005). What is not known is whether contaminants in Delta waterways significantly limit the growth, fecundity, and/or egg viability of delta smelt, or whether contaminant exposure significantly exacerbates problems stemming from water temperature stress and low food density.

This project would serve at least two management needs. First, it would clarify whether contaminants actually are or are not a significant ecological problem for delta smelt, and the experiment could be repeated in the future if new contaminant concerns arise or the project could become part of a monitoring program at a lesser level of effort (e.g., keep one facility operating for a longer time period). Second, this project would be able to discern a range of improvements in delta smelt vital rates, including fairly subtle ones associated with the "fall action", if vital rate improvements are noted from the action.

The objective of this study would be to raise delta smelt in flow-through ambient water systems and to chemically monitor ambient Delta water. The basic study design would be to acquire delta smelt larvae from the Byron facility during spring and grow them to adulthood at the research facilities using the local unfiltered ambient water. Each facility should have batches of fish that feed only on what is in the ambient water, while others should have food added. This would allow the influence of food-limitation to be tested explicitly and simultaneously. Subsets of the fish would need to be sacrificed at intervals to evaluate liver condition, fecundity, etc. The viability of surviving fishes' eggs would be tested against controls from the Byron facility that were grown in filtered Delta water.

Timeline: The project would occur during the Delta Smelt Fall Habitat study identified below and research results would be available annually beginning in year-2.

Pesticides (Pyrethroids) in Delta Smelt. Pesticides are a major group of contaminants that have been implicated in the decline of the Delta smelt, but their relative contribution to the problem is unclear. The hydrologic complexity of the Delta makes it difficult and expensive to measure pesticide concentrations enough times and in enough places to adequately characterize fish exposure to pesticides. A different approach is to "ask the fish" by directly measuring concentrations of pesticides and their metabolites in fish tissue. This approach has been limited by an inability to measure pesticides at low enough concentrations to be able to detect them in individual small fish. Pyrethroid insecticides are one group of pesticides in particular that have increased in use during the time of Delta smelt decline, but are very difficult to measure at environmentally relevant concentrations. Methods to measure more than 100 pesticides and metabolites in fish tissue have been recently developed, and pesticide concentrations, including pyrethroids, in individual Delta smelt collected by ongoing monitoring studies will be measured at low concentrations. These same fish will be assessed for several measures of fish health by other ongoing research studies. Concurrently measuring pesticide tissue concentrations and fish health in individual fish will allow a much stronger statistical analysis of cause and effect. This study will provide valuable information on the relative contribution of pesticides to the decline in Delta smelt.

Timeline: The sampling and analysis will take one year and six months to complete, at which time the results will be available. Manuscripts containing the results will be written by the end of the second year.

Ammonium Concentrations, Distribution and Transport in the Delta. Recent evidence suggests that ammonium delivered from the Sacramento Municipal treatment plant to the Sacramento River affects algal productivity and may play a critical role in pelagic organism decline in the Delta. This study would assess the relative importance and distribution - temporal and spatial - of ammonium and other nitrogen species in the Delta using high frequency measurement. If feasible, the concentrations and distributions of ammonium will be compared to continuous measurements of algal abundance and Delta smelt distributions to infer the potential role of ammonium on Delta smelt. In addition, we will investigate the role of dissolved organic nitrogen (DON) in wastewater and "nutrient spiraling", in which DON is mineralized to

ammonium and may negatively impact algal production, heterotrophic food webs and pelagic organisms.

Timeline: This study should have some usable results within the first year and much more comprehensible results by the end of the second year and published results in year 3.

5. Foodweb Models

While there are many sources of foodweb-type data available for the Delta, there is no current model to incorporate and evaluate that data and predict conditions given varied future proposed conditions. The NMFS Southwest Fisheries Science Center is currently developing a Dynamic Energy Budget (DEB) model to examine food web dynamics.

Dynamic Energy Budget Model. DEB models use differential equations to describe the rates at which individual organisms assimilate and utilize energy from food for maintenance, growth, reproduction and development (Nisbet *et a*l. 2000; Ledder *et al*. 2004). These rates depend on the state of the organism (age, size, sex, nutritional status, *etc*.) and the state of its environment (food density, temperature, *etc*.). Solutions of the model equations represent the life history of individual organisms in a variable environment (Nisbet *et al*. 2000). DEB models are especially useful for understanding the effects of sublethal stresses, which may have effects at times and places later in the life cycle (e.g., warmer water temperatures may reduce growth in the river, potentially increasing size-dependent mortality in the ocean, and retard maturation, increasing exposure to ocean fisheries). In addition to developing a DEB for Chinook salmon, scientists at the SWFSC will collect field data to fill in gaps on salmon diet, growth and prey availability, which is needed to run the model.

Timeline: It is expected that preliminary model results will be completed by May 2011 and final model results should be ready by May 2012.

6. Predation

The following studies are not currently underway and would require additional funding and staffing for their completion:

Predation Studies and Model Creation. While we understand the level of predation for some species in specific areas of the Delta, how those levels relate to other areas and species in the Delta is unknown. In this action, existing predation information would be synthesized into predation models for use in the BDCP/BiOp process. At the same time, contemporary abundance estimates of predatory fish would be developed via new and ongoing (California Department of Fish and Game and University of Washington studies) mark-recapture and acoustic tracking studies for specific regions of the Bay-Delta and rivers. A simulation model would be created to incorporate the results from these studies to fill critical uncertainties about assumed predation effects in specific regions of the Delta and rivers. These tasks are necessary to quantitatively evaluate the effect of predation on the population viability of covered species resulting from the BDCP.

Timeline: This effort would start this year with useful information expected to be available starting in year-2.

Predator Prey Behavior at Large North Delta Pumps and Screens. NOAA's Southwest Fishery Science Center is developing a study to analyze late-fall Chinook salmon survival in the Sacramento River using acoustic technology. This research will be augmented in collaboration with UC Davis to include additional receivers and methods to assess predator prey dynamics near large pumps and screens in the north Delta.

Timeline: This effort would start this year with useful information expected to be available starting in year 2.

7. Delta Habitat Relationships

Habitat studies provide avenues to learn about the likely consequences of Delta restoration choices in much greater detail. They are intended to explore the physical, chemical, and biological processes associated with Delta habitats, including the types of habitat that would be created if Delta islands are flooded, or if Delta flow regimes are modified or evolve over time due to global climate change. The following activities will improve our understanding of Delta habitat issues and address the NAS Report's recommendation to implement the fall X2 action using adaptive management.

Breach III Study. The Breach III study is an attempt to understand and model the biotic and abiotic processes involved with the passive restoration of Liberty Island and would inform flood and erosion hazard management decisions in the lower Yolo Basin. At the same time, it is designed to describe the occurrence and use of aquatic habitats in and around Liberty Island by ESA listed fish species (delta smelt and salmonids).

The purpose of re-initiating and expanding the Delta Juvenile Fish Monitoring Program's (DJFMP) Liberty Island beach seine monitoring program is to evaluate the current use of Liberty Island as habitat by native fishes, particularly delta smelt, splittail, and Chinook salmon. These additional monitoring activities should provide information about the importance of the lower Yolo Bypass area for various life stages of delta smelt and other native fishes. Finally, this monitoring will provide information to assist with developing study designs for other questions such as the HSG's "*How does distribution of delta smelt in the spring and summer affect their distribution and growth in the fall?"*

Questions to be addressed by the study are: 1) what species use the various nearshore habitats provided in Liberty Island; 2) what are the physio-chemical characteristics of the nearshore habitats that contain delta smelt; (3) what are the spatio-temporal patterns of nearshore habitat use by fish in Liberty Island; (4) are delta smelt found within Liberty Island year-round; and (5) what is the abundance and composition of native and non-native species in Liberty Island, how will this composition change over time, and how does the composition compare to other DJFMP monitoring sites?

The objectives of the study are: 1) to document the presence of fish species using Liberty Island; 2) to estimate juvenile, adult, and spawner use by delta smelt and splittail, and assess associated habitat conditions; 3) to estimate larval rearing by delta smelt and splittail, and assess associated habitat conditions; and 4) to estimate salmon fry/smolt use, and assess associated habitat conditions. The study is ongoing and is expected to provide useful data in year-2.

Timeline: This work has been ongoing since January 2010 and will continue on a year-round basis. Egg & larval trawls will be conducted in conjunction with beach seining during February – July, 2010.

Delta Smelt Fall Habitat Evaluations. In its review of the RPA for the 2008 FWS BiOp, the NAS Report concluded that it was critical that the adaptive-management requirements included in RPA Component 3 be implemented in light of the uncertainty about the biological effectiveness of the action and its possibly high water requirements. As part of its efforts to guide implementation of those requirements, the HSG is collaborating with the IEP Pelagic Organism Decline (POD) Work Team on a program to examine the effects of fall X2 on delta smelt habitat (as prescribed in RPA Component 3 of the 2008 FWS BiOp). Integrating with the IEP POD investigations is critical because fall habitat impacts must be considered within the broader context of the full range of factors likely to affect delta smelt abundance. Understanding the effects of fall X2 relative to other factors will be an important consideration in managing RPA Component 3 of the 2008 FWS BiOp.

Timeline: The HSG is developing a multi-faceted study and many of its elements are likely to provide information within the next one-to-two years. Other elements may take considerably longer.

Turbidity Monitoring and Modeling. This effort will develop turbidity modeling capability in the Delta in support of understanding and evaluating the response of the turbidity field to proposed actions (water project operations, gates, barriers, etc.). This modeling capability will be used as a planning tool and for real-time operations, including the ability to predict, as a forecasting tool, the outcomes of a suite of actions on the turbidity field. Improved turbidity monitoring and analysis is also included in the Near-Term Science Strategy accompanying this document.

8. Anadromous Fish Migration Studies

Additional information about the fate and transport of aquatic species through the Delta, including migrating anadromous fishes would be beneficial. The following studies would increase our knowledge about anadromous fish migration through the Delta:

Acoustic Telemetry Studies. Several acoustic telemetry studies are in various stages of planning, implementation, and completion/data analysis. These studies involve tagging large numbers of juvenile salmon and tracking their fate as they migrate down through the system to quantify survival through rivers and the Bay-Delta. NMFS, USFWS, and other Federal and state

agencies have been involved in conducting these studies, primarily on Sacramento River late fall-run Chinook salmon. Additional acoustic tracking studies are necessary immediately to support the BDCP assessment and decision-making. New technology is now available to work with difficult-to-study winter-, spring- and fall-run Chinook salmon. Survival data derived from acoustic studies will be integrated with behavioral and physiological information to support life cycle modeling and viability assessments as part of the BDCP BA and BiOp. Funding is necessary to continue ongoing Delta studies and to obtain new technology for applying these studies to the ESA-listed Central Valley winter- and spring-run Chinook salmon.

Timeline: New information will be available in year-2, with additional results appearing over several years.

San Joaquin River Steelhead Smolt Survival Study. The proportional causes of mortality due to flow, export, and other project and non-project adverse effects on steelhead smolts out-migrating from the San Joaquin basin and through the southern Delta are unknown. This six year experiment will provide important information about the response of fish migration to flows, exports, and other stressors in the San Joaquin River corridor.

Timeline: The preliminary experimental design will be completed by September 2010 for agency review and final study design will be completed and ready for the interagency annual review by December 2010.

ATTACHMENT 2

List of BDCP Covered Species to be analyzed in the Integrated BDCP BiOp

San Joaquin Kit Fox (*Vulpes macrotis mutica*)
Riparian Woodrat (*Neotoma fuscipes riparia*)
Salt Marsh Harvest Mouse (*Reithrodontomys ravivenstris*)
Riparian Brush Rabbit (*Sylvilagus bachmani riparius*)
Townsend's Big-eared Bat (*Corynorhinus townsendii*)
Suisun Shrew (*Sorex ornatus sinuosus*)
Tricolored Blackbird (*Agelaius tricolor*)
Suisun Song Sparrow (*Melospiza meloida maxillaries*)
Yellow-Breasted Chat (*Icteria viriens*)
Western Burrowing Owl (*Athene cunicularia hypugaea*)
Greater Sandhill Crane (*Grus canadensis tabida*)
California Black Rail (*Laterallus jamaicensis coturniculus*)
California Clapper Rail (*Rallus longirostris obsoletus*)
White-tailed Kite (*Elanus leucurus*)
Swainson's Hawk (*Buteo swainsoni)*
Giant Garter Snake (*Thamnophis gigas*)
Western Pond Turtle (*Actinemys marmorata*)
California Red-legged Frog (*Rana draytonii*)
Western Spadefoot Toad (*Spea hammondii*)
California Tiger Salamander (*Ambystoma californiense*)
Central Valley Steelhead (*Oncorhynchus mykiss*)
Sacramento River Winter-Run Chinook Salmon (*Oncorhynchus tshawytscha*)
Central Valley Spring-Run Chinook Salmon (*Oncorhynchus tshawytscha*)
Central Valley Fall- and Late Fall-run Chinook salmon (*Oncorhynchus tshawytscha*)
Longfin Smelt (*Spirinchus thaleichthys*)
Delta Smelt (*Hypomesus transpacificus*)
Sacramento Splittail (*Pogonichthys macrolepidotus*)
North American Green Sturgeon *(Acipenser medirostris)*
White Sturgeon (*Acipenser transmontanus*)
River Lamprey (*Lampetra ayresii*)
Pacific Lamprey (*Lampetra tridentata*)
Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)
Vernal Pool Tadpole Shrimp (*Lepidurus packardi*)
Conservancy Fairy Shrimp (*Branchinecta conservatio*)
Longhorn Fairy Shrimp (*Branchinecta longiantenna*)
Vernal Pool Fairy Shrimp (*Branchinecta lynchi*)
Mid-Valley Fairy Shrimp (*Branchinecta mesovallensis*)
Suisun Marsh Aster (*Symphyotrichum lentum*, formerly *Aster lentus*)
Alkali Milk-Vetch (*Astragalus tener* var. *tener*)
Heartscale (*Atriplex cordulata*)
Brittlescale (*Atriplex depressa*)
San Joaquin Spearscale (*Atriplex joaquiniana*)
Lesser Saltscale (*Atriplex minuscula*)
Slough Thistle (*Cirsium crassicaule*)
Suisun Thistle (*Cirsium hydrophilum* var. *hydrophilum*)
Soft Bird's-Beak (*Cordylanthus mollis ssp. mollis*)
Delta Button-Celery (*Eryngium racemosum*)
Boggs Lake Hedge-hyssop (*Gratiola heterosepala*)
Carquinez Goldenbush (*Isocoma arguta*)
Delta Tule Pea (*Lathyrus jepsonii* var. *jepsonii*)
Legenere (*Legenere limosa*)
Heckard's Pepper-Grass (*Lepidium latipes* var. *heckardii*)
Mason's Lilaeopsis (*Lilaeopsis masonii*)
Delta Mudwort (*Limosella subulata*)
Caper-fruited Tropidocarpum (*Tropidocarpum capparideum*)