

CALFED Bay-Delta ERP Panel Review

Proposal Number: 228DA

Applicant Organization: US Fish and Wildlife Service, US Geological Survey

Proposal Title: Mercury in San Francisco Bay-Delta Birds: Trophic Pathways, Bioaccumulation and Ecotoxicological Risk to Avian Reproduction

Please provide an overall recommendation.

Fund As Is: \$5,337,012

Conditions, if any: None

Provide a brief explanation of your rating:

This proposal addresses topics of significant ecological concern in the Bay-Delta ecosystem: the bioaccumulation of methylmercury in birds and its effects on avian reproduction. The proposed work is expected to provide definitive information on reproductive effects of methylmercury exposure in three feeding guilds of birds in the Bay-Delta ecosystem: surface feeders, obligate fish eaters, and benthivores. Diminished reproductive success could have adverse population-level consequences for birds exposed to high levels of methylmercury.

This proposal is a substantial improvement and integration of two separate proposals submitted previously. The principal investigators have crafted an exceptional proposal that builds on prior studies of the Bay-Delta ecosystem, other ecosystems, and other avian populations. The information provided will be directly relevant to the Ecosystem Restoration Program and to ecosystem managers. The defensibility and utility of the proposed investigation will be strengthened by the integration of field studies with laboratory experiments.

The individuals comprising this team of investigators are renowned for their work in wildlife toxicology and have extensive experience in laboratory and field studies of mercury bioaccumulation and its effects on birds. The methods are documented and scientifically valid. The budget is reasonable given the substantial research effort to be undertaken; moreover, the USGS Patuxent Wildlife Research Center will devote substantial resources to the project during the 3-year project.

One reviewer questioned whether the proposed sample sizes in the field study were adequate to meet the stated objectives, and recommended that the investigators evaluate the adequacy of sample sizes for the various endpoints to be measured. The Panel recommends that the investigators address this question via statistical analysis of variation observed in their prior studies of birds in the Bay-Delta ecosystem. In general, the Panel advises that it would be preferable to devote greater sampling and analytical

effort to a smaller number of colonies and habitats than to spread the resources of the project too thinly across large numbers of sites and bird colonies.

* * *

CALFED Ecosystem Restoration Program External Review Form

Proposal Title: Mercury in San Francisco Bay-Delta Birds: Trophic Pathways, Bioaccumulation and Ecotoxicological Risk to Avian Reproduction

Review:

1. **Goals.** Are the project's goals and objectives clearly stated and internally consistent? What ecosystem restoration benefits will it provide?

The goal of the proposed project is to evaluate the risks of methylmercury to populations of Bay-Delta aquatic birds. Specifically, the investigators propose to integrate laboratory studies of the effects of injected methylmercury on survival of avian embryos from multiple species of wild and domesticated species of birds with field assessments of methylmercury bioaccumulation and reproductive success of aquatic birds representative of three foraging guilds. The objectives and tasks associated with the project goal are clearly stated and consistent throughout the proposal. Information from the project may be used to determine environmental concentrations of Hg that are detrimental to wild populations of coastal aquatic birds and, consequently, assist managers in developing priorities for restoration of habitats that have potential to increase methylmercury exposure to sensitive wildlife species and populations.

2. **Approach.** Is the approach well designed and appropriate for the project's objectives? Is it justified by prior site studies or other information documented in the proposal? If additional information is needed to adequately plan and design the project, does the proposal include adequate provisions for obtaining it during the project's design and environmental assessment? If not, what additional information should be gathered?

The overall approach and project intent is very good. The linkage of mechanistic laboratory studies, including establishment of biomarkers of effect (i.e., oxidative stress), with field surveys of reproductive success among foraging guilds of birds should allow establishment of rigorous cause-effect relationships between methylmercury and reproductive failure in wild populations of birds. However, a serious shortcoming of the proposal is the lack of discussion of experimental design for the field studies and an indication of the adequacy of sample size for both the field and laboratory studies. How many colonies of each species will be monitored? What are the criteria for their selection? The field studies will occur across a landscape that is spatially and temporally variable. How will selection of breeding colonies minimize the effects of factors, other than methylmercury, that may influence reproductive success. For example, it is reasonable to expect differences in reproductive success between colonies nesting on the bay and those nesting on salt ponds due to factors other than methylmercury. Will the experimental design "block" colonies by habitat type? Will there be an attempt to assess reproductive success of colonies nesting on different types of wetlands (agricultural, tidal, non-tidal, etc.) and how will selection of habitat types for study enhance the utility of information for later restoration purposes?

The adequacy of sample sizes for various endpoints should be assessed. The investigators have done extensive preliminary field and laboratory studies and should be able to determine, based on sample variability, the number of samples required to determine sample means with pre-determined precision. For example, 10 avocet and 10 stilt chicks will be sampled for stable isotope, contaminant, and histopathology analyses (page 14). What is the smallest difference in methylmercury concentrations that is detectable 90% of the time with a sample of 10 data and a significance level of 0.05? (or other appropriate questions). Will the number of samples collected be adequate, based on preliminary

sampling, to fulfill the objectives of each task? For mercury analysis? Stable isotope analysis? Reproductive success? Etc.

For the purposes of statistical analysis, how is the experimental unit defined? In the statistical sense, what hypotheses will be tested? How will the large data set be statistically analyzed? This, in part, may be dependent upon experimental design, but will the investigators employ multivariate approaches to analyzing the data or primarily regression and univariate statistical analyses to establish cause-effect relationships? Consideration of data analysis will also aid in the experimental design of the field studies.

The linkage of laboratory and field components is a strong and important component of this proposal. Because of the co-occurrence of other contaminants that may cause reproductive failure, establishment of biomarkers of effect lends weight to any cause-effect relationship established between mercury and bird reproduction. The investigators propose to measure oxidative stress as a biomarker for Hg exposure in the laboratory and also in tern chicks. However, they do not indicate if this biomarker will be measured in stilts, avocets, and diving ducks. I would encourage the measurement of this and other biomarkers in all study species as this would strengthen the relationship between the results of the laboratory and the field. I would also encourage the measurement of a consistent suite of endpoints among all species so that stronger comparisons of relative species sensitivity may be established. As currently proposed, some endpoints are measured in some species, but not in others.

Although a formal ecological risk assessment is not a goal of this study, it may ultimately be beneficial to the investigators and to restoration goals to consider how data could be collected in a way that would later facilitate a probabilistic risk assessment of methylmercury to Bay-Delta aquatic birds.

3. **Feasibility.** Is the approach fully documented and technically feasible? Is the scale of the project consistent with its objectives? Does it reflect “best practices” for this type of project? If not, how should the project be revised to reflect “best practices”? Is it likely to attain the ecosystem restoration objectives it seeks?

The project is ambitious, but technically feasible. If questions concerning experimental design of the field study and sample size requirements can be addressed, then it likely to attain the goals stated by the investigators.

4. **Capabilities.** What is the applicants’ track record in terms of past projects? Is the project team qualified to efficiently and effectively implement the project? Does the proposal describe how additional expertise and other support necessary to successfully accomplish the project will be obtained? If not, what additional expertise or support is needed?

The principal investigators are all highly respected scientists in the field of wildlife toxicology. They have extensive and very good track records in oversight, management, and completion of past projects, including those funded by Cal-Fed. They have assembled a team of highly capable scientists and sub-contractors to complete the proposed work. The PIs may wish to consult with a statistician to assist with the experimental design of the field study and to assist with the large and diverse amount of data that will be collected.

5. **Cost/Benefit Comments.** Is the budget reasonable and adequate for the work proposed?

Though the cost is great, this is an ambitious and extensive proposal. However, it is not possible to comment on the reasonableness of the proposed budget until more detailed information is available on the number of bird colonies that will be sampled and, ultimately, on whether or not the proposed sample size will be adequate to answer the questions posed by the investigators.

Additional comments:

Please provide an overall evaluation summary rating: Excellent: outstanding in all respects; Good: quality but some deficiencies; Poor: serious deficiencies.

Overall Evaluation Summary Rating	Provide a brief explanation of your summary rating
Excellent	I would rate this proposal as good to very good. The overall project goals, objectives, and conceptual approach are excellent. However, the proposal is deficient in addressing the experimental design and sample sizes required to meet the objectives.
Good XXXX	
Poor	

CALFED Ecosystem Restoration Program External Review Form

Proposal Title: Mercury in San Francisco Bay-Delta Birds: Trophic Pathways, Bioaccumulation and Ecotoxicological Risk to Avian Reproduction

Review:

1. **Goals.** Are the project's goals and objectives clearly stated and internally consistent? What ecosystem restoration benefits will it provide?

The project's goals are clearly articulated, and are consistent with one another. The sub-objectives of the proposed field and laboratory research are all appropriate to the overall objective – to evaluate the risks of Hg exposure in aquatic birds that breed and/or feed in the San Francisco Bay area.

The results of the proposed research will provide valuable information on the movement of Hg through the aquatic food webs of the Bay area; the relative sensitivities of various target bird species to dietary methylHg exposure; and will demonstrate whether exposure to Hg in the Bay area is of significant toxicological importance for wild aquatic birds. The proposed research will clarify which species are at greatest risk for Hg toxicity, and indicate the relative magnitude of the risk they experience. Such information is essential to develop sound management and restoration policies. Using information gained through the proposed research, managers will be better able to judge the likely outcomes of different restoration alternatives; and will be better able to test the success of the alternatives that are implemented.

2. **Approach.** Is the approach well designed and appropriate for the project's objectives? Is it justified by prior site studies or other information documented in the proposal? If additional information is needed to adequately plan and design the project, does the proposal include adequate provisions for obtaining it during the project's design and environmental assessment? If not, what additional information should be gathered?

The applicants have recognized the necessity for an integrated field and lab approach to properly assess the effects of Hg exposure on birds in the San Francisco Bay area. The project as described is very comprehensive in its scope; it is difficult to suggest additional information that is not already covered by the study design. The proposal benefits from prior, preliminary assessments, and the choice of species to be studied, and toxicological endpoints to be assessed, are in accord with data from these prior site studies.

The following few critical comments are of a minor nature, but should be considered by the project team when fine-tuning their studies:

1. Although the proposal primarily deals with Hg, other contaminants (eg. – PCBs, PBDEs, and others) will also be measured. Is there any prior evidence that these contaminants are present in birds or other organisms at levels that are of potential

toxicological concern? The application states: “These secondary analytes have been documented at high levels either in representative prey species or within individual adults or their eggs” (pg. 10); however, no actual data are presented, nor are any published references cited to support this statement. Also, within the budget estimates, it is not possible to determine the analytical costs to measure these secondary contaminants, because all estimated analytical costs are combined as ‘Hg and secondary contaminants’ in the detailed budget Tables. The applicants should present a better justification for including these organic contaminants in their study, and identify the relative costs of their inclusion.

2. Inclusion of certain migratory species, such as surf scoters, in the study is in part justified by statements such as: “Diving benthivores, such as surf scoters that winter in the estuary, have some of the highest Hg concentrations reported for adult birds in the ecosystem” (pg. 4); and “Scoters accumulate some of the highest concentrations of Hg (12.5 ppm dw in liver) ... Such concentrations are beyond those associated with adverse effects to reproduction in dabbling ducks” (pg. 7). However, the applicants do not make clear if the Hg present in scoters is in the form of meHg, or inorganic Hg, or some combination of both. Only if the Hg is primarily present as meHg would the stated concentrations be of concern. It is well known that some predatory birds and mammals can accumulate high levels of Hg in certain tissues like liver, sometimes >100 ppm dw, but when present primarily as inorganic Hg, it is of much lower toxicological concern than if it is present as meHg. The applicants should clarify the chemical forms of Hg when making toxicological statements about Hg concentrations in bird tissues.
 3. The applicants state: “Selected biomarkers are indicative of exposure to Hg ...” (pg. 13); and “oxidative stress biomarker for Hg exposure” (pg. 13) will be measured in birds. The impression is left that these biomarkers are specific indicators of Hg exposure, but that is not the case, and the applicants should clarify this point. Exposure to other toxicants, and other conditions such as various disease states, could potentially cause changes in biomarkers of oxidative stress. There is (as far as I know) no specific biomarker of Hg exposure. Also, the “Oxidative stress analysis” description (pg. 63) includes numerous endpoints, many of which are not oxidative stress biomarkers. Changes in these endpoints, as measured in avian blood, although potentially useful, are not specific for exposure to any particular contaminant, such as Hg. This point should be clarified.
3. **Feasibility.** Is the approach fully documented and technically feasible? Is the scale of the project consistent with its objectives? Does it reflect “best practices” for this type of project? If not, how should the project be revised to reflect “best practices”? Is it likely to attain the ecosystem restoration objectives it seeks?

The methods chosen for the proposed research are well documented, and generally recognized by the scientific community to be standardized, scientifically valid procedures. The scale of the project is necessarily large; the authors have recognized the benefits of an integrated field and laboratory approach, and the proposed project is ambitious and comprehensive. The time scale

of the proposed research (approx. 3 years) is suitable for achieving the stated goals and objectives.

4. **Capabilities.** What is the applicants' track record in terms of past projects? Is the project team qualified to efficiently and effectively implement the project? Does the proposal describe how additional expertise and other support necessary to successfully accomplish the project will be obtained? If not, what additional expertise or support is needed?

The project team appears to be very well qualified to conduct the proposed research. Of the applicants, I am best acquainted with the previous work of Drs. Heinz and Hoffman, both of whom are world-class experts in wildlife toxicology, with a particularly high level of expertise in the field of Hg and Se toxicology in birds. It would be difficult to find more highly qualified scientists than these to lead the proposed laboratory studies. Dr. Schwarzbach has conducted field investigations of contaminants in free-living birds, including birds in the San Francisco Bay area, and appears well qualified to lead the field component of the project. The overall project manager (Suchanek) has extensive experience in managing large-scale research projects involving environmental contaminants. In short, the whole research and management team is highly qualified and well able to efficiently implement the project.

5. **Cost/Benefit Comments.** Is the budget reasonable and adequate for the work proposed?

The budget appears reasonable to accomplish the proposed research.

Additional comments:

It was a pleasure to review such a comprehensive and well-designed proposal.

Please provide an overall evaluation summary rating: Excellent: outstanding in all respects; Good: quality but some deficiencies; Poor: serious deficiencies.

Overall Evaluation Summary Rating	Provide a brief explanation of your summary rating
Excellent XX	The proposal has no major deficiencies in any area. The overall study design, feasibility of the work, and qualifications of the research team are all outstanding; the project deserves an overall rating of 'excellent'.
Good	
Poor	